Exploring environmental innovation journeys: An ethnographic study in a firm from the UK food and farming sector

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Exploring Environmental Innovation Journeys: An Ethnographic Study in a Firm from the UK Food and Farming Sector

Per-Anders Axel Langendahl

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Abstract

Environmental Innovation is seen as vital for sustainable futures. Knowledge about environmental innovation is sought in various contexts and recent thinking recognizes this as a process that unfolds in time and space. Environmental innovation journeys are therefore the subject of a growing literature. However, little is known about how environmental innovation journeys actually proceed in various contexts, how we might make sense of these and intervene to attain more sustainable futures. This thesis begins to address this gap in knowledge. It reports ethnographic research undertaken to explore an environmental innovation journey situated in a firm from the UK food and farming sector. Data were collected from multiple sources via multiple methods including participant observation and semi-structured interviews.

This thesis shows that the environmental innovation journey is non-linear, involving temporary fixes and is reversible. This insight accords with recent constructivist accounts of environmental innovation. Inspired by the work of John Law, these were drawn upon to make sense of the environmental innovation journey without compromising reality. Seen in this way, environmental innovation journeys involve developing, maintaining and deleting situated practices. This involves processes that are shaped by competing environmental discourses, which manifest in the firm as storylines and images of performances required of practices. Thus, the contribution of this thesis is to offer an approach to making sense of environmental innovation journeys, which may be used in other contexts and which can be adapted as appropriate by actors involved.

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Per-Anders Langendahl, July 2012

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1 Introduction

This chapter provides a brief overview of the subject and research approach of this thesis, the research context, overall aims and objectives and how the thesis is structured.

1.1 Environmental Innovation Journey

A key focus of this thesis is on Innovation Journeys. The concept of the Innovation Journey builds on the idea that the emergence of novelties is situated and unfolds through time and space (Van de Ven et al., 1999; Rip and Schot, 2002). Following this conception, the environmental innovation journey can thus be thought of as the emergence of novelty to achieve, among other things, resource productivity (Geels et al., 2008). In food and farming sectors, resource productivity refers to the challenge of reducing the use of natural resources needed in food production, e.g. water, energy and land use, while maintaining or increasing the level of product outputs (IMECHE, 2013). (Appendix A provides a glossary of key terms used in this study).

The idea of environmental innovation journeys has received growing interest in recent sustainability debates (Schot and Geels, 2008) and lends itself usefully to understand how environmental innovation might unfold inside a firm. However, this line of research is in its infancy, to date involving only a few studies (c.f. Van de Ven et al., 1999; Schot and Geels, 2008). One approach draws on innovation management studies and offers insight to innovation journeys in firms (Van de Ven et al (1999). However, this insight does not say anything about environmental innovation journeys in a firm. Another approach identifies sustainable innovation journey and focuses on transition to sustainable socio-technical systems (Geels, 2002; Schot and Geels, 2008). A key development in this approach is the multi level perspective (MLP), which involves different levels of structuration.

The concept of structuration builds on the work of Giddens (1984) and emphasises that actors are embedded in structures. These structures exist as rules, e.g. way of understanding the world around us, and resources, e.g. people, things and their use. These structures are constructed by people. Hence, while people are embedded in structures, they also reproduce these structures. This means that people draw upon structures so as to perform actions. Seen this way, structures are something that is constraining as well as enabling human action.

Schot and Geels (2008) suggest that less structured novelties emerge and are developed in protected niches, and over time proceed (or not) through alignment to wider diffusion into society in which they become embedded and contextualised. However, the MLP provides limited insight to what is going on inside firms as part of a transition.

There is thus a gap in knowledge of how we might understand environmental innovation journeys inside firms. This study focuses on an account of the environmental innovation journey inside a firm from the UK food and farming sector. A relationship with a UK food processing firm provided the researcher with an opportunity to explore how environmental innovation unfolds inside, while not being limited to, this Firm[1]. Subsequently, this study therefore identifies a second gap in knowledge – that of a detailed understanding of an environmental innovation journey in the food processing sector.

[1] This study was undertaken as a case study in a UK food processing firm, which refers to the Firm. Details about the Firm are provided in chapter 4.

Literature on environmental innovation in the UK food and farming sector is found to be limited to studies focusing on how to promote environmental best practice in farming on the one hand and consumer attitudes on the other (Lowe et al., 2008). However, literature on environmental innovation in this sector does not say much about how this phenomenon unfolds in firms (Donald, 2008). Food processing firms hold a key intermediate position in the food supply chain involving relationships to, among others, farmers, food manufacturers and food retailers.

This introduction has identified a need to address two gaps in knowledge: (1) the idea of environmental innovation journey is an emerging field of research, but how this process might be understood inside a firm is largely absent, and (2) literature on environmental innovation in the UK food and farming sector with particular reference to food processing firms is limited. Following these identified gaps in knowledge the following research question was identified:

- How does the environmental innovation journey unfold in a firm from the UK food and farming sector?

The purpose of this study was therefore to explore how the environmental innovation journey unfolds in a firm from the UK food and farming sector. The following section provides an overview of the research approach developed in this study to address these gaps in knowledge.

1.2 Research approach

In much of the literature, environmental innovation in general, and the environmental innovation journey in particular, is found rooted in realist perspectives in social sciences.

Seen this way, problems of unsustainability such as climate change are out there but we in society can resolve these by adding more knowledge and technologies. We address environmental problems through deliberate shifts in knowledge and technologies to move society away from unsustainability (Ehrenfeldt, 2008). Rip and Schot (2002) offer an understanding of innovation journeys involving technological change.

In understanding innovation journeys as process through time and space, Rip and Schot (2002) do not deny that the emergence of novelty in the real world is complex. Nevertheless, the authors argue further that a universal theory is necessary to understand how the (environmental) innovation journey unfolds (Rip and Schot, 2002). The complexity of the real world is simplified into a stylist account: a theory that is rich enough to capture the complexity of the (environmental) innovation journey, yet simple enough to enable general application in different contexts. A typical innovation journey is therefore one that proceeds through discrete stages from innovative niche, through to alignment and wider diffusion into society.

Realist accounts of the (environmental) innovation journey therefore conceive process as progress towards predefined goals such as sustainability. The purpose of such studies is to provide policy makers and planners with an understanding of how to facilitate technological change in, for example, a firm and promote best environmental practice. The utility of understanding technological change is essential because innovation journeys are seen as irreversible (Rip and Schot, 2002). Early intervention involving key actors is therefore perceived to be necessary to get moving in the right direction, which is believed to be achieved by removing non-technical barriers to this end (Guy and Shove, 2000).

In broad terms, these non-technical barriers involve:

- a lack of information or knowledge among potential actors to acquire technologies that can resolve predefined environmental problems;
- financial incentives, which are insufficient to motivate investment in new 'sustainable' technologies, and
- regulatory structures that do not support technological change.

Seen this way, (environmental) innovation journeys appear as potentially controllable processes involving the pursuit of drivers and avoidance of barriers that determine the success or failure of environmental innovation. However, drawing on literature in sustainable architecture, Guy and Shove (2000) challenge the utility of realist accounts.

The focus on non-technical barriers is underpinned by the assumption that problems of unsustainability such as climate change can be solved by providing key individuals with more information, incentives and sanctions. In this way, realist accounts tend to emphasise key actors, such as firms, at the expense of considering the contributions of other actors. Moreover, what goes on inside firms is 'black boxed'. The term 'black box' refers to the idea that the social process of environmental innovation, e.g. decisions made by people in a firm, is replaced with assumptions about rational behaviour (Moss et al., 2005). However, recent social studies of technologies and innovation shows that such assumptions are often at odds with actual behaviour (Guy, 2006).

Thus, realist accounts overlook the actual processes through which environmental innovation is introduced in particular contexts (Beveridge and Guy, 2005). Literature on innovation in general has failed to incorporate the 'messiness' of processes of environmental innovation and the interplay of many actors. Actual processes of interaction and negotiation through which novelties emerge in particular time and space contexts are black boxed.

Beveridge and Guy (2005) argue that there is a need to "*look at the roles played by actors in all realms of activity- scientific, technical, social, political- touched by an innovation, and realize that it is only by following the innovation process through its twists and turns, leaps and dead ends that we can begin to understand why innovation succeeds or fails* (2005:673). This constructivist approach opposes the idea of trying to find a single frame of reference, a theory to understand reality (Rorty, 1998). Instead, this constructivist approach highlights the need to uncover how innovation is made.

Following constructivist commentators in social sciences, a research perspective and not a theory was adopted in approaching this study. This constructivist perspective highlights the need to understand the actual process of what is going on inside a firm undertaking an environmental innovation journey. This approach accords with Guy and Moore who argue that: "*the challenge of sustainability is more a matter of local interpretation than the setting of objectives or universal goals* (Guy and Moore, 2005:1).

This study therefore set out to explore an account of the environmental innovation journey following this constructivist perspective. Research methods developed in this study to explore an account of the environmental innovation journey involved ethnographic approaches such as participant observation and semi-structured interviews. The following section provides the scope of this study.

1.3 Research scope

The scope of this study is an account of the environmental innovation journey identified in a firm from the UK food and farming sector. The following section provides a background to this study with reference to (1) the research context, and (2) the researcher.

1.3.1 The research context: A Firm in the UK food and farming sector

This study set out to explore an account of the environmental innovation journey in a firm from the UK food and farming sector. The **'Firm'** is a UK food processor holding an intermediate position in the UK food supply chain. The Firm is specialised in sourcing raw materials such as potatoes from farmers and runs a factory in which potatoes and other vegetables are peeled, diced and packed. The finished products are sold as ingredients to food manufacturers using these ingredients to make ready meals. A ready meal is a prepared meal ready to eat by consumers. These ready meals are typically sold in supermarkets.

Although this study was undertaken inside the Firm, this does not mean that this study is limited to the Firm's physical boundaries. The Firm is rather identified as a site in which many actors and technologies interact. The Firm involves many actors on the inside who form relationships with actors that are traditionally seen as external to firms in general such as suppliers, customers, consultants and so on. The UK food and farming sector, in which the Firm is situated, is a diverse industry involving many actors such as farms, food processors, manufacturers, catering, retailers and consumers.

A typical description of the food industry is the 'commodity chain' in which the principal actors involved in production and provision of food are depicted (Pothukuchi and Kaufman, 2000, in Donald, 2008). Figure 1.1 illustrates the position of the case study Firm in the food commodity chain including key environmental impacts associated with food production beyond the farm gate.

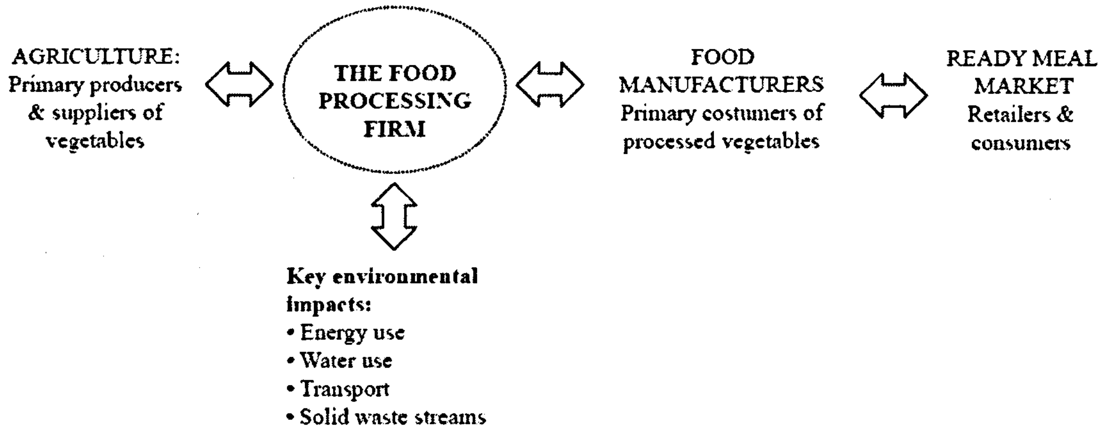

Figure 1-1: The research scope with reference to the Firm in the UK food supply chain and associate environmental impacts

This UK food processing Firm holds an intermediate position in the food supply chain. Environmental impacts associated with actors beyond the farm gate, i.e. food processing and manufacturing in particular, are energy consumption, water use and solid waste streams. A DEFRA (2006) report found that the UK food industry, with particular reference to food processing and manufacturing, accounts for 14% of energy consumed by total UK business; 10% of industrial use of public water; 25% of HGV[3] kilometres; and 10% of industrial and commercial waste streams. Food processing is a major industrial sector with substantial environmental impacts.

The UK food policy approach seeks, among other things, to encourage 'best environmental practice' in terms of methods and technologies used in food sectors to improve environmental performance. The development of best practice is being sought through

[3] HGV: Heavy Goods Vehicles
[6] Over the period of the research the Firm had three Managing Directors, who are labelled MD1, MD2 and MD3.

collaboration between industrial actors such as the Food and Drink Federation and UK government programmes to suit specific challenges (FDF, 2010).

A corporate environmental strategy was identified by the Firm's managing director prior to the start of this research project. This strategy was developed in the Firm by the MD1[6] and involved work undertaken by the Researcher (Langendahl, 2008). The stated aim of this strategy was to enhance the Firm's competitive advantage by improving its environmental performances (i.e. energy use, water use, transport and solid waste). This study builds upon this earlier work with this project's PhD studentship being sponsored by the Firm. This relationship with the Firm provided the Researcher with an opportunity to participate and observe how an environmental innovation journey actually unfolds. The following section therefore introduces the researcher as participant in the Firm's environmental innovation journey.

1.3.2 The researcher

Prior to this PhD, the researcher studied at the Swedish University of Agricultural Science (SLU) with focus on natural resources and economics. The final year involved an MSc in environmental management for business at Cranfield University in the UK. The Researcher was involved in work undertaken with Supervisor 1[7] in the UK food processing Firm as part of completing the MSc. This project focused on the development of a corporate environmental strategy in the Firm (Langendahl, 2008).

The relationship with the Firm provided an opportunity for the Researcher to undertake a PhD project focusing on environmental innovation in the Firm. This study is sponsored by the Firm. An ethnographic approach was developed involving methods such as participant

[7] There are two supervisors involved in this thesis, hence Supervisor 1 and 2.

observation and semi-structured interviews. The Researcher engaged with the Firm in the beginning of this project. As a participant of the Firm's environmental innovation journey, the Researcher could explore how environmental problems and solutions are constructed in the Firm following a constructivist perspective.

1.3.3 Research process: a progressive funnel

A progressive funnel approach, inspired by Hammersley and Atkinson (1995), was adopted in this study to explore the environmental innovation journey. The concept of progressive funnel refers to the idea that the research process becomes gradually more focused as the study proceeds. The beginning of the funnel refers to the start of the study where a gap in knowledge was identified. This gap identified the following broad and open-ended research question:

- How does the environmental innovation journey unfold in a firm from the UK food and farming sector?

This question refers to the emerging idea of environmental innovation journeys, and exploring how it unfolds inside a firm and can be accounted for. The relationship with a UK food processing firm provided the Researcher with an opportunity to address this gap in knowledge.

An exploratory research approach was adopted to collect and analyse data. Following constructivist commentators in social sciences it was found useful to conceptualise the environmental innovation journey as a social process involving the construction of environmental problems and solutions. Hence, a research perspective and not a theory was adopted in the approach to this study. Subsequently, the Researcher identified a relevant framework found in literature to guide data collection, which was then analysed in light of this literature.

Hence, in this exploratory study, data collection, analysis and literature review was interlinked in what can be described as an iterative process. It was iterative because literature informed data collection and analysis, which stimulated further research. Frameworks that accord with data collected in this study were selected, while those that were found less useful to make sense of data were deselected. This research process, depicted as a progressive funnel, is ongoing until exploratory research is completed. Exploratory research is completed when new insights are realised so as to satisfy research objectives identified in light of the research question. These research objectives emerged and were refined through data collection and analysis in light of theoretical frameworks found in literature.

The beginning of the research funnel of this study is summarised:

- **Gap in knowledge**: The idea that environmental innovation unfolds through time and space, environmental innovation journeys, is underdeveloped. Not much is known about environmental innovation in food processing firms.
- **Research perspective**: A constructivist perspective was adopted in approaching this study: the environmental innovation journey is a social process involving the construction of environmental problems and solutions.
- **Method**: Ethnographic case study undertaken in a UK food processing Firm to explore and account for the environmental innovation journey

A research perspective inspired by constructivist commentators was adopted to explore an environmental innovation journey in the Firm. Ethnographic methods involving participant observation and semi-structured interviews developed in this study to collect data. As the study proceeded, the researcher identified a way to understand the environmental innovation journey involving insight from literature to make sense of this process. The research perspective changed as this study developed. This research process is depicted as a funnel provided in Figure 1.2.

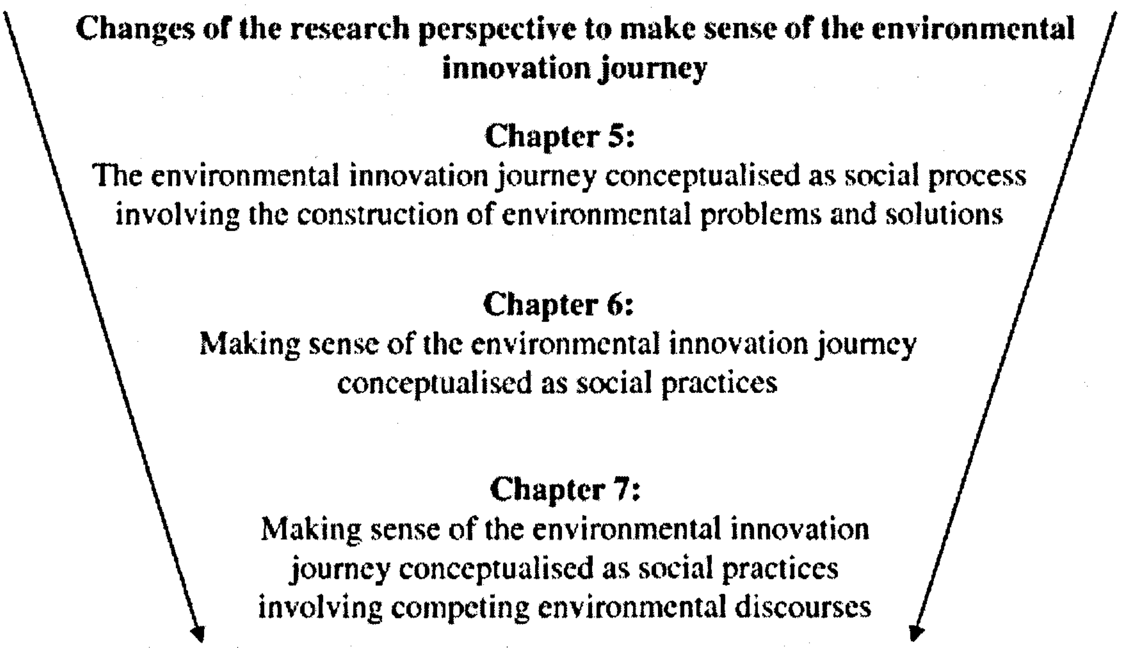

Figure 1-2: An illustration of the research process as a progressive funnel

As illustrated in Figure 1.2, chapters 5, 6 and 7 provide the research findings and reflect how this study developed to make sense of environmental innovation journeys. This research funnel informed the development of research aim and objectives in this study. The research aims and objectives are outlined subsequently.

1.3.4 Research aim and objectives

How does the environmental innovation journey unfold in a firm from the UK food and farming sector is the research question that underpins this study. To address this questions a constructivist perspective in social sciences was adopted. The aim of this study was therefore to explore how the environmental innovation journey, conceptualised as a social process, unfolds in a firm and to identify ways to account for this process. This firm is a food processing Firm situated the UK food and farming sector. In this study, "*environmental innovation is something that is 'constructed', enabled and made real through constant negotiation between actors in specific contexts*" (Beveridge and Guy, 2005:674)

Following constructivist commentators in social sciences, a research perspective and not a theory was adopted in approaching this study. Instead, different theories, concepts and ideas of Environmental Innovation were considered throughout this study. The following research objectives were therefore identified, in light of the research question, at the early stage of this study:

1. To identify and critically reflect on theories of environmental innovation with specific reference to the environmental innovation journey conceptualised as a social process
2. To identify and critically reflect on environmental innovation in the UK food and farming sector
3. To identify and critically reflect on the environmental innovation journey conceptualised as a social process involving the construction of environmental problems and solutions

Research objectives 1, 2 and 3 were developed to enable an understanding of environmental innovation involving different perspectives. Literature was consulted to aid data collection in the Firm to make sense of the environmental innovation journey as one involving the construction of environmental problems and solutions. This exploration identified a messy and complex reality that did not accord with realists' accounts that are often neat and tidy. However, following Beveridge and Guy (2005) this does not mean that we cannot make sense of environmental innovation process.

This study was inspired by the work of Law (2004) who argue that reality is messy and frameworks that are too neat and 'clean' are rather making a mess describing it. The term 'mess' is here used in a relative sense: reality is much more messy and complex than what realist 'clean' accounts suggest. Following this methodological perspective it was found useful to develop a representation from this ethnographic case study without making a mess accounting for the environmental innovation journey. Drawing on practice theory of innovation (cf. Shove and Walker, 2010; Pantzar and Shove, 2010) the following objective was developed.

4. To identify and critically reflect on the environmental innovation journey conceptualised as social practices

Practice theory offered a way to make sense of the environmental innovation journey as social practices. A practice consists of people working in conjunction with technologies to produce performances in relation to their imaginings of environmental problems and performances required to resolve these. Environmental innovation journeys conceptualised in this way involve developing, maintaining and deleting situated practices. The term situated practices refers to the idea that practices are contingent upon particular time and space contexts (Shove and Walker, 2010). Seen this way, a practice only exists through successive moment of performances in terms of what people actually do. In other words, a practice can not be separated from its context (Guy, 2006).

The analysis of social practices shows that images of performances required of practices shape environmental innovation journeys. However, this practice theory of innovation is limited to understand how images of performances shape practices; why certain practices are developed and others only refined or even deleted. This insight stimulated further research to explore competing environmental discourses (c.f. Hajer, 1995). The following objective was developed.

5. To identify and critically reflect on the environmental innovation journey conceptualised as social practices involving competing environmental discourses

Environmental discourses were found useful to explore in order to understand how practices develop through time. Following Dryzeck (2005), this insight shows that broad environmental discourses exist in society involving reference to 'good environmental businesses. Participants in the Firm draw on these broad ideas to develop story-lines that manifest in practices as images of performances. Story-lines that are pervasive and persuasive were found shaping, to some extent, environmental innovation journeys in the Firm.

1.4 Thesis structure

This section provides an overview of the thesis structure.

1. Introduction
The introduction provides an overview of the thesis and outlines the purpose of this study. This chapter further includes the research context and background, and identifies the aim and objectives of this study.
2. Literature review
This chapter reports findings from a literature review undertaken throughout this study to aid sense making of an environmental innovation journey inside a firm. First, this chapter explores what literature on environmental innovation in the UK food and farming sector says about food processing firms. Second, different theories, concepts and ideas of environmental innovation are explored. The literature on environmental innovation in general is divided into three distinct strands. These are (1) innovation in discrete environmental technologies, (2) transition to sustainable socio-technical system, and (3) practice theory of (environmental) innovation. Third, the concept of environmental innovation journey is identified. This chapter concludes by identifying gaps in knowledge and research perspective to address these.
3. Method
This chapter presents the method developed in this study to explore the environmental innovation journey. A method was not selected 'off the shelf' to collect and analyse data; instead how this was achieved developed throughout this study. This chapter therefore begins by introducing the options available to studies undertaken in a real life situation with reference to the following components: (1) the purpose of the study, (2) the role of theory, (3) research questions, (4) methods for data collection, and (5) data analysis. This chapter describes all method applied in this study subsequently. A flexible research design was selected for this study in which these components described above are not fixed. The research design developed in this study is ethnographic case study involving participant observation and semi-structured interviews to collect data. Data collection, data analysis and literature review developed simultaneously in what can be described as a progressive funnel.
4. The case study

This chapter introduces the case study. The study was undertaken inside, but not limited to, a UK food processing firm. This chapter therefore includes the Firm's commercial context with reference to its position in the food supply chain and operational functions. The environmental management identified in the Firm with reference to relevant environmental regulation is described in this chapter.
5. Exploring the environmental innovation journey: how environmental problems and solutions are socially constructed and proceed over time
This chapter focuses on an account of the environmental innovation journey. Ethnographic methods involving participant observations and semi-structured interviews were used to achieve insight to this context. Findings are presented in a temporally ordered narrative. This account is structured around situations in which environmental problems and solutions are constructed, and the key actors' involved. This insight accords with constructivist views in social science: the environmental innovation journey is shaped by contextual factors involving multiple views on environmental problems and solutions. The environmental innovation journey identified in this study is at odds with the unilinear model, and can rather be characterised as a multiple, contingent and fluid process. This insight stimulated further research to identify a different way to make sense of the environmental innovation journey.
6. Making sense of the environmental innovation journey without making a mess: environmental innovation conceptualised as social process
This chapter draws on practice theory to make sense of the environmental innovation journey. Inspired by recent literature on environmental innovation (c.f. Shove and Walker, 2010; and Pantzar and Shove, 2010) that builds on Giddens (1984), social practice is identified as the unit of analysis. A Social practice consists of participants working in conjunction with technologies to produce performances. Environmental problems are discrepancies between present and required performances identified by participants. In this analysis, the environmental innovation journey is conceptualised as many interlinked social practices. This insight show how new practices are made; and how existing practices can change or are deleted. Practices are undertaken for a reason. This insight stimulated further research to explore those reasons at play conceptualised as environmental discourses.
7. Exploring the environmental innovation journey conceptualised as social practices

involving competing environmental discourses
This chapter presents findings from discourse analysis to identify how competing environmental discourses shape the environmental innovation journey. Inspired by literature (c.f. Farmer and Guy, 2001) who follow the Focuauldian tradition (c.f. Hajer, 1995) a discourse is a claim to knowledge produced in, but not limited to, social practices. Environmental discourses are multiple and compete: those that are socially accepted legitimize certain practices while others are delegitimized. This insight shows how the environmental innovation journey, conceptualised as many interlinked practices, is shaped by competing environmental discourses.
8. Discussion and Conclusion
This chapter revisits the gap in knowledge this study set out to explore and the research approach developed to address this gap in knowledge. The findings from exploring and making sense of the environmental innovation journey are discussed in light of the relevant literature identified in chapter 2. A critical reflection on the research design for this study is provided including discussion on research qualities. The conclusions identify the utility of this constructivist perspective to make sense of the environmental innovation journey. Insights generated from this study can aid others to make sense in different contexts. Research recommendations are provided to researchers and practitioners interested in exploring the environmental innovation journey.

2 Literature review

This chapter draws on the literature on environmental innovation reviewed throughout this study. The literature review is structured as follows:

2.1	**Introduction**	The purpose of undertaking a literature review and the research objectives addressed in this literature review
2.2	**Environmental innovation in the UK food and farming sector**	An overview of key literature on environmental innovation in the UK food and farming sector in general and food processing in particular.
2.3	**Environmental innovation: theories, concepts and ideas**	An overview of the key literature on environmental innovation is provided in 4 sections: Innovation in discrete technologies Transition to sustainable socio-technical system Practice theory of innovation The environmental innovation journey
2.4	**Summary and Critical reflection**	A summary and critical reflection identifies Gaps in knowledge: (1) literature on environmental innovation in the UK food and farming sector with reference to food processing firms is limited, and (2) the idea that environmental innovation is situated and unfolds through time and space has received growing interest in sustainability debate, however, not much is known how an environmental innovation journey unfolds inside a firm. Research perspective developed to address identified gaps in knowledge

2.1 Introduction

The development of modern food production has emphasised food security and food safety to enhance food productivity and public health as well as making food affordable and accessible to consumers (Donald et al., 2008). However, this industrialisation of the food and farming sectors generates substantial environmental impacts (Green et al., 2003). The Cabinet Office (2008) identifies food production and consumption to account for 18% of the UK green house gas emissions, 26% of all electricity, gas and water used in the UK, and 14% of all UK transport. Recent UK food policy identifies a need to enhance resource productivity of food production through environmental innovation.

This study focused on an account of environmental innovation in a firm situated in the UK food and farming sector. A distinct theory was not adopted in approaching this study. Literature on environmental innovation was rather explored throughout this study in light of data collected in the food processing firm concerned. The following research objective was therefore initially identified:

- **Research Objective 1**: To identify and critically reflect on environmental innovation in the UK food and farming sector

Objective 1 is addressed by this literature review. A critical reflection on literature on environmental innovation in the UK food and farming sector shows a gap in knowledge in literature about this phenomenon with specific reference to food processing firms. Hence, different theories, concepts and ideas of environmental innovation were explored throughout this study. The literature explored throughout this study identified the emerging idea that innovation is situated and unfolds through time and space. This insight identified the following research objective:

- **Research Objective 2:** To identify and critically reflect on theories of environmental innovation with specific reference to the environmental innovation journey conceptualised as a social process .

Objective 2 is also addressed in this literature review. A critical reflection shows a gap in literature to understand how an environmental innovation journey unfolds through time and space with particular reference to a firm. In much of the literature on environmental innovation firms are 'black boxed'. This means that knowledge about what goes on inside a firm undertaking an innovation journey is replaced with assumptions about how this process unfolds. For example, Tidd et al. (2008) identify a linear model of innovation process, not necessarily environmental innovation, which proceeds from idea to implementation and completion. However, social studies of environmental innovation show that such process is much more messy and complex (c.f. Beveridge and Guy, 2005).

This literature review identifies two gaps in knowledge (1) literature on environmental innovation in the UK food and farming sector does not say much about this phenomenon with specific reference to food processing firms, and (2) recent literature on innovation builds on the idea that innovation is situated and unfolds through time and space, but says very little about environmental innovation journeys inside a firm.

A research perspective is developed to address these two gaps in knowledge. Following constructivist commentators in social science, the environmental innovation journey can be conceptualised as a social process involving the construction of environmental problems and solutions.

Having introduced an overview of this literature review above, the following sections will subsequently unpack research objective 1 and 2.

2.2 Environmental innovation in the UK food and farming sector

Research on environmental innovation in the UK food and farming sector has traditionally identified environmental impacts associated with agriculture and the primary production of food (Pretty, 2002; Filson, 2004; and McNeeley and Sherr, 2003). However, recent literature on environmental innovation in the UK food and farming sector identifies the need not only to understand environmental innovation in farming, but also to include other actors beyond the farm gate such as food processing, manufacturing and food retail (Spaargaren et al., 2012; Green et al., 2003). This section explores what literature says about environmental innovation in the UK food and farming sector with reference to food processing firms in particular.

The UK food and farming sector is a diverse industry involving many actors such as farms, food processors, manufacturers, catering, retailers and consumers (Yakoleva, 2007). A typical description of the food industry is the 'commodity chain' in which the principal actors involved in production and provision of food is depicted (Pothukuchi and Kaufman, 2000, in Donald, 2008; Yakoleva, 2007). An illustration of the UK food supply chain is provided in Figure 2.1.

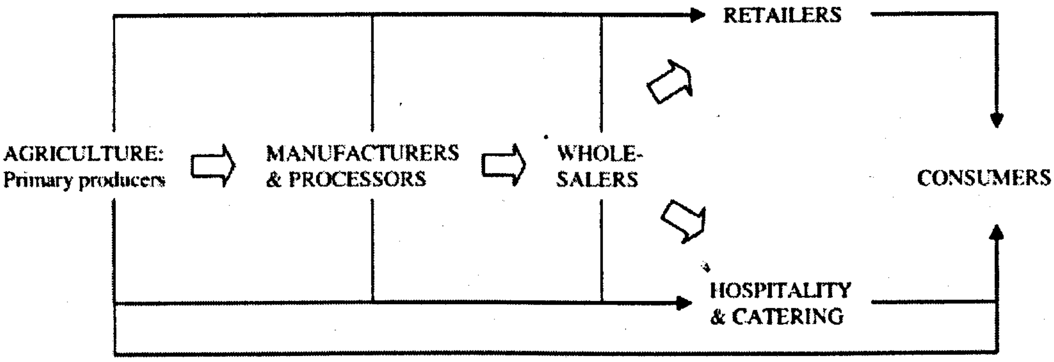

Figure 2-1: The UK food chain involving key actors responsible for food production and supply and their interrelationship (Own development inspired by Pothukuchi and Kaufman, 2000)

Studies that focus on environmental innovation in the UK food and farming sector were found rooted in this food chain approach with particular reference to commodities. For example, Yakoleva (2007) explores the environmental impacts of production and supply of chicken and potatoes using a sustainability assessment model. The study builds on quantitative data collected from each stage of the commodity chain with reference to, among other things, energy consumption and water use (Ibid). This account thus identifies the need for environmental innovation at various stages in the commodity chain. However, the study says very little about how environmental innovation unfolds in the food and farming sector.

A different study focuses on frozen peas and explores the environmental impacts as well as the need for transformation of the food system (Green et al., 2003). This systemic approach focuses on the provision and supply of food and seeks to identify all the relevant actors and institutions responsible for the production, processing, distribution, consumption of food. The underlying theory in this systemic approach is that all parts of the system must be sustainable (cf. Green et al., 2005). Environmental innovation in the food and farming sector is therefore understood as a systemic shift to sustainable food production and consumption (cf. Green and Foster, 2005; Lifset and Graedel, 2002).

A systemic shift refers to a transformation of the whole food system involving all sectors such as farms, processing, manufacturing and retail, and their interrelationships (Green et al., 2003; Smit et al., 2008; Sundkvist et al., 2005). This line of research is structured around the following identified elements:

- individual food commodities, e.g. chicken and potatoes;
- the commodity chain involving those actors involved in primary production through to consumption and food disposal;
- environmental impacts associated with each actor;
- the interrelationship between key actors involved.

Details about this systemic approach are provided subsequently.

2.2.1 Systemic transformation of food production and supply

In their systemic approach, Green et al (2003) and Green and Foster (2005) identify different ways to organise the food system to move away from unsustainable food production and consumption. The present food system is characterised as an industrialised system with particular reference to food productivity. Innovation in food production during the past 50 years has led to an intensive primary production (i.e. agriculture) involving an increase of external inputs, e.g. fossil fuels, and agro-chemicals, e.g. pesticides and fertilisers, (Pretty, 1998; Stoate et al., 2001).

This industrialisation of food production has also led to increased specialisation of individual actors seeking economies of scale. For example, Sundkvist et al (2005) argue that trends in food processing and manufacturing show a shift towards a few large industrial actors replacing many small ones. A consequence of this industrialisation of food production is the distance in terms of time and space it creates between consumers and food providers.

Modern food industry involves global relationships with many commodities transported long distances (Hollander, 1995; Bonanno et al., 1994). Consumers are therefore disconnected from those actors involved in food production and supply (Pretty, 2002). Moreover, the production and supply of food is largely concentrated around key actors holding a powerful position in the commodity chain such as large firms involved in agricultural inputs, e.g. seed manufacturers, processing, manufacturing and the retail market (Atkins and Bowler, 2001; Hendrickson and Heffernan, 2002). It is not possible to achieve sustainable food production unless all these actors make deliberate shifts in contributing to this transformation.

It is widely argued that the present industrialisation of food production and supply should be dismantled and replaced with other means of primary production, food processing, manufacturing and retailing as well as shift in consumer demand (Green et al., 2003; Green and Foster, 2005). A transformation of the present food system involves alternative technologies but also change in the social and economic structures that can support alternative methods of food production and supply. Green and Foster (2005) follow Elzen et al (2004) and suggest a socio-technical system of provision as the unit of analysis to understand transformation in the UK food and farming sector.

Green et al., (2003) identify three distinct strategies to organise the food system in contrast to the present industrialised food system. These are (1) the traditional sustainable; (2) the organic-, and (3) the new industrial food system. These distinct strategies are described in broad terms below.

- **The traditional sustainable**: this strategy is inspired by production and consumption systems found in poorer countries in which traditional methods of food production involve small scale agriculture. The principal advantage of this strategy is the emphasis on local knowledge regarding the natural environment in relation to food habits.
- **The organic strategy** is one that emphasises production methods that emphasise the health of both humans and the natural environment. This includes minimising pollution generated at farms and the maintenance of biodiversity. Advocates of this organic food system identify environmental innovations to avoid chemical inputs such as synthetic pesticides and fertilisers. For example, recycle of waste from farms to use as fertiliser on farms and identify natural protections against potential crop damage, however, without the use of genetic modification.
- **New industrial:** this strategy seeks to restructure present food production and supply with an emphasis on new technologies. This new industrial approach involves particular reference to scientific and technological development that can usefully be applied to food production. This includes for example, new methods to manage crops using information technologies and use of genetically modified crops.

In creating such shifts in socio-technical systems, innovation in both socio-economic arrangements and technological change with reference to products and processes is required. Green and Foster (2005) identify the factors that can enable or constrain the food system as it operates now with particular reference to technological knowledge, societal characteristics, resource flows and economic conditions (Green and Foster, 2005:675). In their study on frozen peas, Green and Foster (2005) unpacked these essential factors that shape production and supply of this commodity.

The technological knowledge was found embedded in large firms such as Uniliver and their investments in R&D to improve production and supply of frozen peas. Hence, Uniliver is identified as the agent in the food system of this particular commodity in producing and interpreting the meaning of sustainability. However, other factors in this system that influence the production and supply of frozen peas involve transport and refrigeration to extend shelf-life and consumer diets that shape the demand for this commodity.

The research on innovation in the UK food and farming sector with particular reference to environmental innovation involves studies focusing on the food system (cf. Green et al. 2003; Green and Foster, 2005; Yakoleva, 2007; Sundkvist et al., 2005). This systemic approach identifies what a system may consist of (e.g. key actors involved) and what a system deemed to be better may look like. The latter represents future sustainable scenarios. However, these accounts do not say much about how innovation for sustainable futures emerges and unfolds.

Furthermore, these systemic approach studies tend to emphasise food production and supply of commodities on the one end and consumers' attitude to food commodities on the other (Lowe et al., 2008). However, fewer studies have explored environmental innovation and the role of individual firms in food production (Donald, 2008; Fortuin and Omta, 2009). The following section turns to literature on innovation and food processing firms.

2.2.2 Food processing

Food processing firms holds an intermediate position in the food supply chain with relationship to primary production at one end and food manufacturers and retailers at the other. The principal role of food processing firms is to transform raw materials, e.g. potato, into 'useable' food products through activities such as cleaning, dicing and packaging. Food processing firms thus have an important link between primary production and the rest of the food commodity chain. The environmental impacts associated with food processing include particular reference to the use of packaging, but also water consumption, energy use and transport (Green et al., 2003).

Only a few studies were identified in literature that explore innovation with reference to food processing firms. Fortunin and Omta (2009) focused on innovation (and not environmental innovation) in the Dutch food processing industry and identified the main drivers and barriers to innovation in this sector. Their study shows that pressure to innovate in food processing firms arises from the retail sector (Ibid). This insight accords with Smit et al (2008) who argue that the development in the potato commodity chain is concentrated to a few retailers. This suggests that the retail sector holds a powerful position in relation to food processing and is therefore identified as a key driver to innovation.

Fortuin and Omta (2009) identify the main barrier that constrains innovation in food processing as the relationship between food processing firms and their suppliers at one end and buyers, e.g. retailers, at the other. The potential for innovation is underutilised because food processing firms are engaged in multiple relationships with many suppliers and buyers. However, studies on innovation in food processing firms do not say much about environmental innovation in general, and how such innovation journeys unfold in particular.

2.2.3 Critical reflection on the literature on environmental innovation in the UK food and farming sector

The purpose of this literature review so far had been to identify what literature says about environmental innovation in the UK food and farming sector with particular reference to food processing firms. This following section provides a critical reflection on this literature review as stated in research objective 1.

Studies focusing on innovation in the UK food and farming sector with reference to environmental impacts tend to emphasise systemic approaches. The present food system is characterised as an industrialised system that is unsustainable. Innovation is needed involving alternative methods for primary production, processing, manufacturing and retailing of food, holding the potential to achieve a sustainable food system.

The systemic approach to understand innovation in food production tends to focus on individual commodity chains and the inter-relationship between key actors. Environmental impacts are identified at each stage of the commodity chain in which agriculture is often referred to as the site where environmental impacts are most severe. The underlying theory in this systemic approach is that all actors involved must change in order to move away from unsustainable food production.

Literature in this systemic approach focusing on the food commodity chain points out powerful actors such as retailers and what factors (e.g. consumers' diet), are driving innovation in food production. However, literature on environmental innovation in the food and farming sector does not say much about the role of individual firms (Donald et al., 2008). Food processing firms hold an intermediate position in food production and supply and may be of interest to understand environmental innovation in the UK food and farming sector. Many actors are interconnected to the food processing stage because of the flow of material and information up and down the food supply chain.

There is paucity in literature on environmental innovation in food and farming sectors. This paucity is, first, literature on environmental innovation in this sector does not say much about how such processes unfolds. Second, innovation accounts do not provide insight on how environmental innovation unfolds in a food processing firm in particular.

This critical reflection on literature focusing on environmental innovation in the UK food and farming sectors shows a gap in knowledge in understanding environmental innovation in food processing firms. This gap in knowledge identifies a need to explore different ways to understand environmental innovation in the UK food and farming sector with particular reference to food processing. The following section explores alternative theories, concepts and ideas to understand environmental innovation in a UK food processing firm.

2.3 Environmental innovation, theories, concepts and ideas

The following section presents a review of literature identified in this study to make sense of an account focusing on environmental innovation in a UK food processing firm. This literature review identified different theories, concepts and ideas of environmental innovation, which are divided into four distinct strands. These are:

- Discrete environmental technologies;
- Transition to sustainable socio-technical system; and
- Practice theory of (environmental) innovation.
- Environmental innovation journey

The principal difference between these four strands is the unit of analysis identified to account for environmental innovation. Each strand is presented subsequently below.

2.3.1 Discrete environmental technologies

A distinct strand in literature on environmental innovation identifies discrete environmental technologies as the unit of analysis. This line of research focuses on the development of discrete environmental technologies and conceives their uptake in various contexts (Berkhout, 2002). This emphasis on technological change follows the notion of ecological modernisation and the view that modern technologies are seen as the cause of many environmental impacts and identifies the need for ecologically sensitive technologies. Seen this way, environmental innovation involves purposive development of technologies that can resolve environmental problems (Huber, 1995; Berkhout and Gouldson, 2003). Following Weale (1992) ecological modernisation is a government led programme of action involving strategic policy planning to induce technological change in firms so as to remove environmental problems.

Governmental policy intervention is thus seen as a key facilitator to achieve innovation in technologies (Welford et al., 2004; Foxon et al., 2005), while firms are identified as the site in which such technologies are required (Ehrenfeldt, 2008). A classification of discrete environmental technologies available to firms ranges from end-of-pipe technologies to cleaner technologies and cleaner products (cf. Skea, 1995; Van Hemel, 1998; and Horbach et al., 2007). Table 2.1 provides an overview of discrete environmental technologies and their typical characteristics.

Table 2-1: A typical classification of discrete environmental technologies and their characteristics (Own development inspired by Hamel, 1999)

Discrete environmental technologies	**Characteristics**
End-of-pipe	Technical devices retrofitted to existing technologies to avoid or mitigate environmental impacts, e.g. emission filters.
Cleaner technologies	Redesigning technologies in production process as to reduce resource use and/or pollution at source.
Cleaner products	Redesigning products or developing new products as to achieve superior environmental performances

Traditional environmental policy is rooted in a command-and-control regime to protect natural environments, which have influenced firms to develop end-of-pipe technologies. However, it is widely argued that end-of-pipe technologies cannot resolve environmental problems that are distant in time and place such as deterioration of natural resources and climate change (Murphy and Gouldson, 2000;Welford, 2004; Horbach et al., 2007). Hence cleaner technologies and cleaner production are needed.

The process through which discrete environmental technologies are developed and diffused is described as a linear progression involving intervention, design and demonstration, through to application and dissemination (Foxon et al, 2005). Studies in this line of research focus on the factors that influence or inhibit this process as to making a move from one stage to another towards identified goal such as substantial reduction in energy consumption.

Policy intervention identified to stimulate development and uptake of cleaner technologies in the UK food production includes (1) knowledge dissemination, (2) financial incentives/disincentives and (3) regulatory sanctions (Pretty, 2002). These policy interventions are:

- **Knowledge dissemination**: involves recommendations given to farmers and provided by organizations funded by the government. These recommendations are usually in the form of codes of good agricultural practices such as information about application rates of pesticides and fertilizers. This policy instrument relies on voluntary engagement of farmers.

- **Financial incentives and disincentives**: involve economic measures developed to ensure that the polluter bears the cost of environmental impacts it causes and the abatement cost of controlling the pollution. Economic measures can also work as incitement for good behaviour with reference to environmental impacts. Those economic measures that work on the 'polluter pays principle' include taxes, charges and tradable permits. The alternative to taxes and charges are economic measures that promote the adoption of non-polluting technologies and practices. For example, governmental organizations can offer subsidies for the adoption of environmental technologies at farms.

- **Regulatory sanctions**: are measures established by governmental organizations involved in UK food and farming. This policy instrument can either involve emission standards for the discharge of specific pollutant or a quality standard for the natural environment receiving the pollutant. However, emissions arising from farm activities such chemicals that leak into water are diffuse and not easy to detect. This policy instrument therefore involves a challenge for the regulator to ensure compliance with established standards.

The purpose of policy intervention is to overcome those barriers that arise at different stages of the development and uptake of discrete environmental technologies. Rennings (2000) identifies the determinants of innovation with specific reference to discrete environmental technologies as (1) technology push (e.g. ways to achieve energy efficiency), (2) regulatory push (e.g. environmental legislation), and (3) market pull (e.g. customer demand).

Different types of policies are identified at each stage of an environmental innovation (Kemp et al., 1998). Typical policy measures required at the early stage to create technology push include support for research and development, and support for demonstration projects of new technology. Policy measures required subsequently to create market pull and achieve further diffusion of discrete environmental technologies are (1) development of long range targets and obligations (e.g. national commitment to reduce CO2 emissions), and financial incentives such as capital subsidies and tax measures to encourage market selection (Foxon et al., 2005).

Studies that take discrete environmental technologies as the unit of analysis tend to identify policy intervention as the agent of change. Policy acts on firms to stimulate development and uptake of discrete environmental technologies. However, this line of research does not say much about the process inside firms. Research that focuses on the process through which innovation emerges in firms identifies a complex interplay of many influential factors, which cannot be reduced to mechanisms of market pull and technology push stimulated by policy intervention (Nemet, 2009; Siebenhüner and Arnold, 2007). In contrast, studies on environmental (or sustainable) innovation in firms focus on decisions made by firms in terms of identifying and adopting of discrete environmental technologies. Studies that draw on this view are presented below.

2.3.1.1 Sustainable innovation in firms

Literature that focuses on sustainable innovation in firms makes reference to innovation that is economically, socially and environmentally sustainable, and thus essential to firm survival. In broad terms, sustainable innovation is understood as a process involving the emergence of novel ideas in firms to improve social, economical and environmental performances of a product or operation in relation to current situation (Siebenhüner and Arnold, 2007). In accounting for sustainable innovation, research in this field seeks to understand decisions or strategies developed by firms' in response to challenges of unsustainability (Gouldson, 2008).

In understanding decision making in firms, Gouldson (2008) identifies two types of influences (1) external pressure that stems from governmental intervention, markets and civil society, and (2) internal conditions with reference to corporate strategy and capacity for innovation. The external pressure influencing firms' decision making can be conceptualised as the external selection environment. Green et al. (1994) identify the following key factors external to firms:

- The cost of factor inputs such as raw materials needed in production
- The cost of capital equipment such as machines and building needed for production
- Market conditions and demand for the firm's products
- Competition in the market such as rival firms
- Legal and regulatory structures

Decisions made by firms are determined by these external forces and shape technologies applied in firms. In accounting for the internal conditions inside firms Roome (1994) identifies four discrete firm strategies to identify solutions to environmental impacts. These are: non-compliance, compliance, compliance-plus and excellence, which coincide with the framework of discrete environmental technologies.

- Non compliance refers to those firms that have no particular strategy to manage environmental problems. Here, end-of-pipe technologies may apply as 'cleaning up' measures to manage environmental impacts such as treatment of contaminated land.
- Compliance strategy refers to those firms that have developed a reactive nature to environmental problems, e.g. end-of-pipe technologies, with particular reference to environmental regulation. For example, installing an emission filter to achieve a particular quality standard of the natural environment.
- Compliance-plus strategy refers to those firms that seek to do more than just complying with environmental regulations such as adopting cleaner technologies to achieve resource productivity.

- Excellence refers to those firms that seek to develop 'cleaner' products and services with superior environmental performances.

Strategies developed by firms determine the potential for sustainable innovation. The process through which sustainable innovation is realized in a firm is understood as a process that involves three general phases (Sorli and Stokic, 2009). These phases of an innovation process are:

- The strategic phase in which the firm identifies the potential for sustainable innovation, selects opportunities and develops new ideas
- The initiation phase in which the firm evaluates the feasibility of selected ideas and identifies the relevant resources required to realise the innovation
- The realisation and management of innovation through which the innovation is implemented

Arnold and Hockerts (2011) provide an illustration of sustainable innovation presented in Figure 2.2.

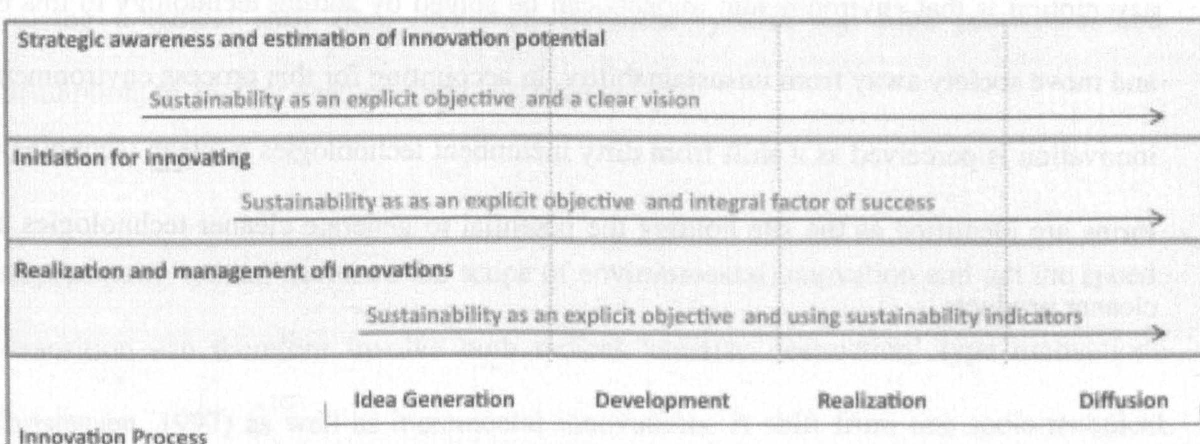

Figure 2-2: Sustainable innovation in a firm
(Adopted from Arnold and Hockerts, 2011)

Arnold and Hockerts (2011) identify the main steps to achieve sustainable innovation in a firm. These steps include:

- nourish entrepreneurial vision so as to identify sustainable innovation;
- make sustainability a firm specific goal;
- integrate sustainability vision and goal throughout the firm via top-down management; and
- identify, develop and execute firm specific programmes such as education, reporting and auditing.

This line of research focusing on sustainable innovation in firms identifies discrete steps and essential characteristics that determine innovation undertaken by firms to address environmental impacts.

2.3.1.2 Reflection on literature focusing on discrete environmental technologies

Literatures on environmental innovation that focus on discrete environmental technologies conceive the development and uptake of these in various contexts. The underlying assumption is that environmental impacts can be solved by adding technology to this end and move society away from unsustainability. In accounting for this process environmental innovation is perceived as a shift from dirty incumbent technologies to clean technologies. Firms are identified as the site holding the potential to generate cleaner technologies and cleaner products.

This line of research tends to focus on the internal motivations, also known as strategies, developed in firms in responding to environmental problems. Internal motivations are shaped by factors in the external selection environment such as policy and market conditions. Policy interventions include a combination of market pull and technology push involving (1) knowledge dissemination, (2) financial incentives and disincentives, and (3) regulatory sanctions. However, this focus on policy measures does not say much about the processes inside firms.

The process through which an innovation is developed in firms is typically described as a linear process involving the emergence of an idea through to selection and adaption. The focus on discrete environmental technologies identifies what elements are involved such as policy, firms and technologies. However, this line of research does not say much about the actual process through which innovations unfolds. A different strand focuses on transition to sustainable socio-technical system involving particular reference to time.

2.3.2 Transition to sustainable socio-technical system

Literature on transition to sustainable socio-technical systems identifies the need to address persistent environmental problems such as food and energy crisis (Grin et al., 2010). Unsustainable production and consumption patterns cannot be resolved with incremental innovation or short term technical fixes (Geels et al., 2008). Instead, a transition is required involving a radical shift from one socio-technical system, e.g. food production and consumption, to another deemed more sustainable.

Here, the term 'radical' refers to the scope of environmental innovation and not the speed. A transition can therefore involve both radical 'creative destruction' type innovations (Christensen, 1997) as well as incremental innovations. A shift from one socio-technical system to another takes time; a transition can take up to 40 to 50 years. For example, building on historic case studies Geels (2005) show how transition from horse-drawn carriage to automobiles, and hygienic transition from cesspools to sewer systems from the 1840s to the 1930s (Geels, 2006).

Transition literature focuses on the socio-technical system as the unit of analysis to account for innovation. Transition in socio-technical systems builds on a co-evolutionary perspective, which includes multiple processes of institutional, technological, ecological, economical, and behavioural processes, e.g. markets and consumers, which are intertwined and reinforce each other.

A socio-technical system is defined as configurations that work (Rip and Kemp, 1998). The configuration refers to the elements involved in the socio-technical system with reference to multiple actors such as market, government and society and the relationships between them. Society consists of many socio-technical systems. These socio-technical configurations 'work' to fulfil functions in society e.g. energy, food and mobility.

The analytical concept developed to account for transition to a sustainable socio-technical system is the multi level perspective and is illustrated in Figure 2.3 (Kemp et al, 1998; Geels, 2002). This framework consists of three nested levels with vertical integration: socio-technical niche, socio-technical regime and socio-technical landscape. Drawing on structuration theory (Giddens, 1984) these levels are differentiated by the degree to which they are more or less structured:

- Landscape: socio-technical landscape comprising highly structured elements that are deeply embedded in society such as infrastructures and culture

- Regime: socio-technical regime comprising less structured configurations of elements that work to meet societies need for functionality, e.g. food
- Niche: socio-technical niches comprising novel development that emerges in loose configuration of elements that are not part of the regime

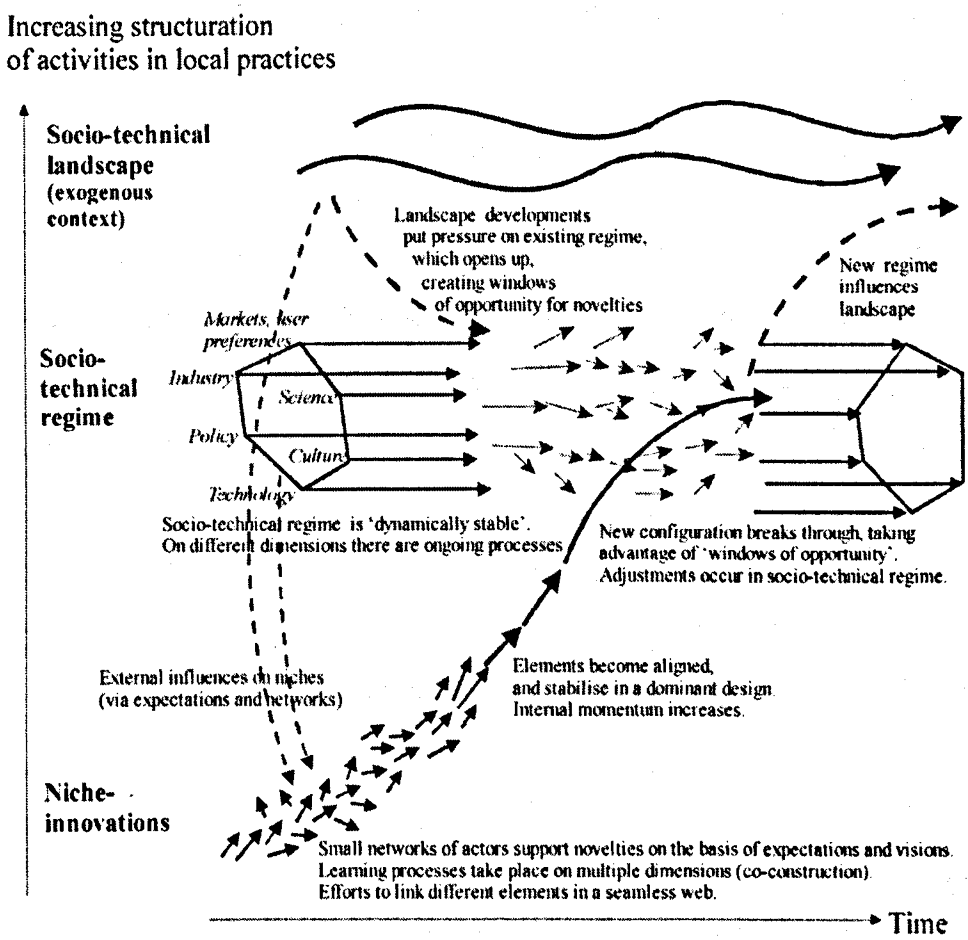

Figure 2-3: The multilevel perspective on transition (Adopted from Geels, 2002)

The focus in the Multi Level Perspective (MLP) on transition to sustainable socio-technical systems exceeds the level of firms or population of firms, but it is more specific then a society or a world system. The MLP is rather focusing on the messo level, which is in between the macro and the micro level. In this perspective, transition occurs at the messo level involving multiple interactions with landscape level and niche level. The emergences of new configurations that work are developed in socio-technical niche environments. The

MLP therefore dismisses the traditional S-shaped curve to account for technological change.

Instead, technological change is understood as socio-technical transition that occurs through multi-level interactions between messo, landscape and niche level. The little arrows in Figure 2.3 refer to the uncertainty and flux of emerging socio-technical configurations. New configurations can be developed in socio-technical niche environment and subsequently taken up in the regime (which is described in section 2.4.1). However, new socio-technical configurations, also described as niche-innovations, may struggle to compete with the existing regime.

Drawing on structuration theory and evolutionary economics, socio-technical systems are stabilised through mechanisms of 'lock-in' and path-dependency (Unruh, 2000). The concept of 'lock-in' builds on Nelson and Winter (1982) and refers to the knowledge and routines developed in a specific community of engineers to solve problems. These inter-locking routines comprise specific problem-solving heuristics that guide development in a particular direction: a technological trajectory, which restricts transition to new technical regimes. Specific problem-solving heuristics make engineers look in a particular direction, while making them blind to other potential developments that are outside of their focus. Hence, technological trajectories are characterised by incremental 'stepwise' innovation to improve technological and economic performance. A transition is described as a break from an existing socio-technical regime involving the emergence of 'new' technological trajectories.

New socio-technical trajectories emerge in niche environments, however, not without a struggle. Niche-innovations face the following typical barriers.

- New technologies fail to meet the expectations of regime actors. For example, genetically modified food products are developed in niche environments, but consumers in the regime do not want to buy them (yet),
- Novel technologies can face a mismatch with existing regime
- The external landscape supports the existing regime.

A change in the socio-technical landscape can pressurise the regime to create a window of opportunity for novelties developed in protected niche environments.

The advantage of MLP is that it accounts for multiple actors involved. This macroscopic perspective focuses on the socio-technical system as the unit of analysis such as energy and food, and accounts for the totality of relevant actors. This stand in contrast to literatures concerned with discrete environmental technology because social and technical go together. This refers to the idea that innovation is socio-technical. This means that people do things in conjunction with technologies. Hence, innovation is more than a change in distinct technologies. It is therefore useful and valid to account for change in both people behaviour and technologies to understand innovation process. The MLP usefully accounts for socio-technical interactions at different levels and how technologies change over time.

2.3.2.1 Reflection on literature focusing on transition to sustainable socio-technical system

The MLP is an analytical concept to account for transition to sustainable socio-technical systems. Research in this field therefore seeks to understand (1) how transition from one socio-technical system has emerged and proceeded in the past such as historic case studies, and (2) how purposive transition to a sustainable socio-technical system can be achieved and governed. However, this perspective is not without criticism. One criticism concerns the nature of transitions. Transitions involve a shift from one socio-technical system to another.

In accounting for transition, it is not possible to study future and existing transitions. Future transitions have not started and existing transitions are ongoing (Grin et al., 2010). Hence, in developing this theory, Grin et al (2010) identify historic case studies to account for transition from beginning to end and verify the MLP. However, historic case studies can be problematic for a number of reasons to develop a theory (Genus and Cole, 2008).

- First, in this approach, case studies are selected by the researcher. There is a danger that the researcher selects a case study that is suitable to confirm the MLP rather than challenging it.
- Second, historic case studies use secondary data. There is a danger of using such data because it can involve accounts produced for other purposes and be flawed.
- Third, historic case studies involves decisions made by the researcher that are not always sufficiently justified such as the beginning and the end of transition, the development of technologies at different levels in relation to the actors involved.

The utility of the MLP to understand future transition to a sustainable socio-technical system is criticised. Shove and Walker (2010) argue that the MLP on transition overly emphasises the provision and supply of functionality. The MLP is a framework to understand and promote different ways to achieve resource productivity to meet existing social needs and functions such as food and energy. However, the unit of analysis to account for transition (understood as a shift from one socio-technical system to another) does not account for everything. The MLP is rather a middle-range theory and is not designed to provide insight to 'local' projects e.g. a firm.

Shove and Walker (2010) argue that the multilevel perspective focusing on transition to sustainable socio-technical system ignores the patterns of demand. For example, while MLP is a framework to explore transition in different socio-technical regimes such as energy (Raven, 2006), food (Smith, 2006) and water (van der Brugge et al., 2005), cooking is a practice that cuts across all these different regimes as the practice of cooking involves energy for heating the stove, food ingredients and water for cooking, and transport to and from the supermarket (Hargreaves et al., 2011). Hence, patterns of everyday life do not fit in a particular regime.

In response, Shove and Walker (2010) build on structuration theory (c.f. Giddens, 1984), arguing that rather than the socio-technical system, practice should usefully be the unit of analysis, illustrated in Figure 2.4.

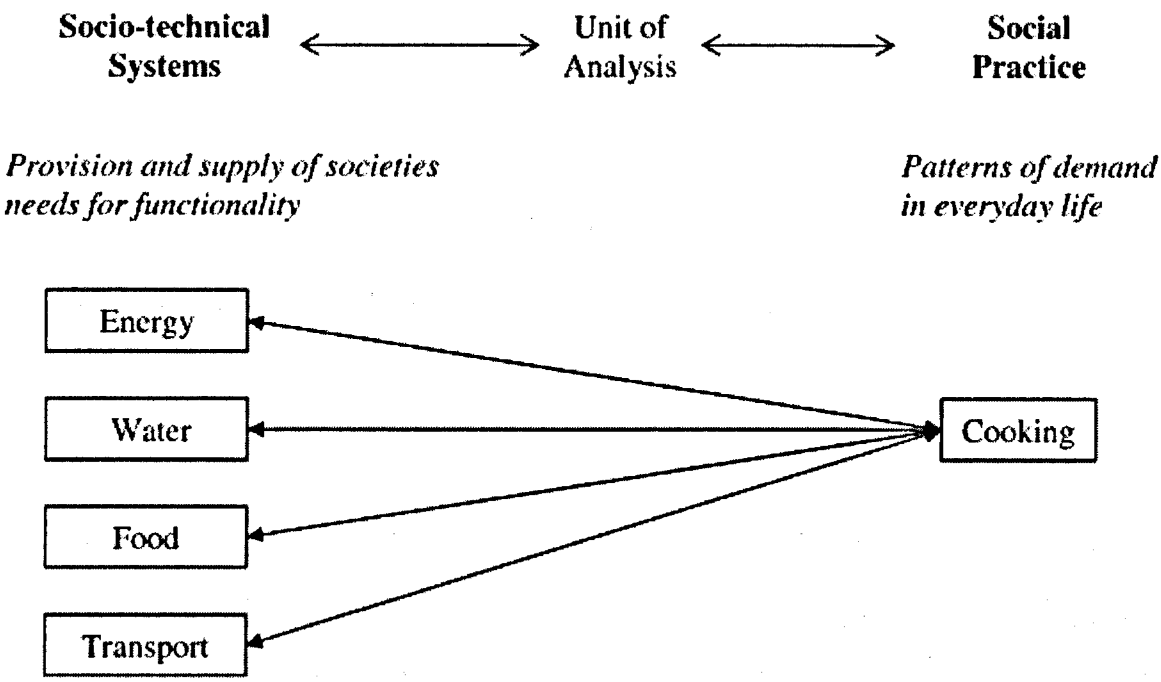

Figure 2-4: Practice theory focuses on social practices, e.g. cooking, as the unit of analysis to understand innovation and challenge the utility of socio-technical system (e.g. energy, water, food and transport) as unit of analysis (own development inspired by Hargreaves et. al., 2011)

Practice theory of innovation challenges the utility of the multilevel perspective to understand innovation. Practice as the unit of analysis has emerged in recent literature to account for patterns of demand in everyday life. The following section explores this practice theory of (environmental) innovation.

2.3.3 Practice theory of innovation

Shove and Walker, (2010) argue that practice should be the unit of analysis, focusing on the 'doing' in which the patterns of everyday life are produced. However, practices are more than what people do and include many elements. Reckwitz (2002 defines practice as follows:

"A routinized type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a

background knowledge. A practice- a way of cooking, of consuming, of working, of investigating, of taking care of oneself or others, etc. – forms so to speak a' block whose existence necessarily depends on the existence and specific interconnectedness of these elements, and which cannot be reduced to any one of these single elements'" (Reckwitz, 2002: p259-250)

Practices are made of many interconnected elements that constitute practices and produce patterns in everyday life. In a more recent study, Shove and Pantzar (2005) simplified this practice model into three interlinked elements that constitute practices, these are: image, skills and materials.

- Image refers to the symbolic meaning that renders practice legitimate,
- skill refers to the knowledge required to produce practice, and
- materials refers to the things other than humans that are usefully involved in practice.

These three elements constitute practice, which cannot be reduced to any of these single elements. Pantzar and Shove (2010) applied this practice-model to focus on an account of Nordic Walking to understand innovation. Nordic Walking is a form of speed walking with two sticks that was first established in Finland in 1997 and grew rapidly to involve more than seven million practitioners in over 30 countries (Shove and Pantzar, 2005). The elements of Nordic Walking involve (1) the image of outdoor activity and recreation, (2) skill in the form of walking with sticks, and (3) material in the forms of two sticks.

In this, practice theory innovation is not understood as innovation in product - such as two sticks, but in what people do, i.e. Nordic Walking. This way of understanding innovation challenges traditional accounts of innovation. Innovation in practice is a process with reference to those who do. Theorists of this practice view of innovation seek to understand how practices are formed, changed or unmade with reference to the elements and the links between elements: how links are made, maintained or broken. In accounting for innovation in practice, Pantzar and Shove (2010) identify three discrete processes depicted in Figure 2.5. Innovation in practice is described in bullet points below.

- First, the elements of practice can exist prior to actual practice. For example, in the case of Nordic Walking that emerged in Finland there were already people that enjoyed walking outdoors, but without two sticks. The third (material) element emerged prior to Nordic Walking became a practice. This process of practice refers to proto-practice.
- Second, the elements of practice are brought together for the first time and produce practice. The links between the discrete elements are made. However, in order for this practice to exist, Nordic Walking must be reproduced by those who do. Hence, this practice view of innovation celebrates practices as ongoing process.
- Third, the elements of practice, and the links between them can be broken. Practice can be unmade, which here refers to ex-practice.

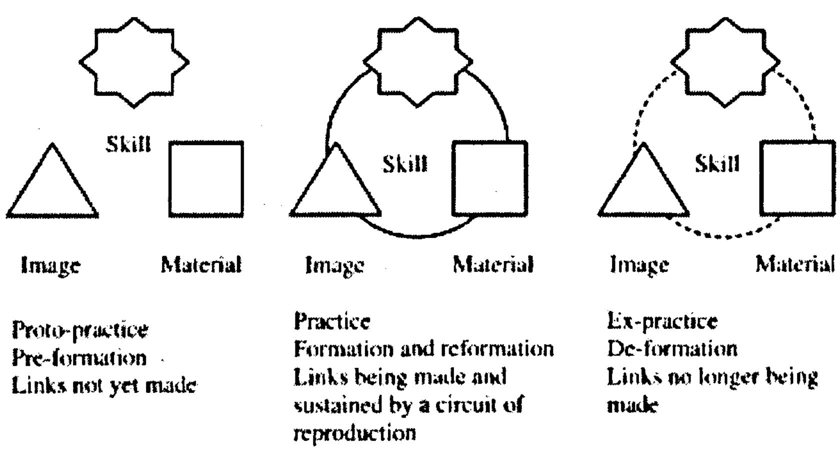

Figure 2-5: Practice theory of innovation: proto-practice, practice, and ex-practice (Adopted from Pantzar and Shove, 2010)

The elements of Nordic Walking have histories of their own: the image of recreation exists regardless of Nordic Walking, walking sticks exist, however, usually as a single stick, and walking skills have history of their own. Hence, producing two sticks for walking is only part of the innovation process. It is rather when people produce Nordic Walking that innovation is complete.

Drawing on structuration theory (Giddens, 1984), this practice theory of innovation shows how new practices can be made and how such practices can stabilise though repeated integration of elements by practitioners. In contrast to traditional account of innovation, practice theory identifies innovation in practice as an ongoing process. Innovation in practice is therefore not only a shift in discrete technology, nor is it a shift in the provision and supply of socio-technical system, but rather understood as patterns of demand in everyday life.

Similar to theorists focusing on socio-technical regime, practices stabilise. Innovations in practice are maintained and stabilised through three distinct circuits of reproduction (Pantzar and Shove, 2010). First, although distinct elements in practice are independent these elements can reinforce each other. For example, laundry liquids used in laundry practices can reinforce a particular image, e.g. clean clothes, and skill, e.g. using a washing machine. A new laundry liquid that requires less water and lower temperature may not be useful unless the practitioner uses a different laundry machine or learns to wash at 30 degrees rather than 60 degrees.

Second a 'circuit' of reproduction concerns the interconnection of many practices that reinforce each other. For example, showering is a practice that is reinforced by architectural practices including ways of thinking and building homes in which showers are usually included. Third, circuit of reproduction refers to the temporal dynamics of different practices: how current practices involve elements with a past, and therefore contain seeds for future practices.

Practice theory of innovation offers a way to understand practices and how circuits of reproduction, described above, stabilise practices. Environmental innovation in practices is therefore understood to be the breaking of links that can usefully kill off those practices that are unsustainable, while making links to elements that can make practices less unsustainable. This practice theory usefully accounts for innovation in 'local projects' e.g. a firm. In contrast to transition in socio-technical systems, this practice theory identifies innovation as an ongoing process. New practices can be made and new elements can intertwine and change existing practices. Importantly, practices are reversible.

2.3.4 Reflection on literature on practice theory of innovation

The advantage of this practice theory of innovation is the emphasis on the pattern of everyday life. However, research in social practice theory has focused on routines and reproduction of practices, while practice theory of environmental innovation is underdeveloped. Literature on social practice theory does not say much about the development and integration of 'novel' elements such as elements that hold the potential to reduce environmental impacts, or configuration of many elements that produce practices that are less unsustainable (Shove, 2012).

Drawing boundaries of practice as the unit of analysis involves similar challenges as those boundaries in MLP: the decision is made by the researcher. For example, in the case of Nordic Walking, the authors did not account for the use of two sticks which is common in skiing: a practice with two sticks and two skis that is performed in the winter in Finland and other places. Perhaps Nordic Walking was inspired by this practice and involves people who wish to extend their use of two sticks while exercising outdoors in the summer.

2.4 A critical reflection on literature on environmental innovation

This section draws on the key literature identified in the previous sections and summarises the key findings of that literature. The idea of innovation journeys found in literature is described subsequently and identifies a gap in knowledge. A research perspective was developed from constructivist commentators at the beginning of this study. This constructivist perspective is explicitly unpacked in this section. The research question is presented in section 2.4.2 and research objective 3 is presented at the end of this chapter in section 2.4.5.

This literature review on environmental innovation, presented in previous sections identified multiple strands. One strand focuses on the development of discrete environmental technologies and conceives the uptake of these in various contexts. The development of discrete environmental technologies is described as a linear path involving intervention, design, demonstration, through to application and dissemination. This line of research identifies what elements are involved such as firms and focuses on what factors influence innovative activities. However, studies that focus on discrete environmental technologies do not account for the actual process through which innovations develop.

Another strand focuses on transition to sustainable socio-technical systems. The MLP is an analytical concept to account for transition as a shift from one socio-technical system to another deemed to be more sustainable. Research in this field therefore seeks to understand (1) how transitions from one socio-technical system have emerged and proceeded in the past, such as historic case studies, and (2) how a purposive transition to a more sustainable socio-technical system can be achieved and governed. However, this perspective is not without criticism. Among other things, Shove and Walker (2010) argue that the MLP emphasises the provision and supply of functionality, while ignoring demand-side factors.

A third strand identifies practice as the unit of analysis and focuses on patterns of demand in everyday life. This line of research concentrates on the elements of practice, e.g. image, skill and material, and identifies innovation as the making and breaking of linkages between them. Rather than follow a linear progression, practices can be made, remade and unmade, and are therefore refined and even reversible. Practice theory of innovation usefully explores how innovation unfolds in particular places (c.f. Pantzar and Shove, 2010).

Recent literature on innovation identifies the idea that innovation is situated and unfolds through time and space and conceptualises this process as an innovation journey (c.f. Schot and Geels, 2008; Rip and Schot, 2002; Van de Ven et al., 1999). Following this conception, the emergence of novelty to improve, among other things, resource productivity can be thought of as an environmental innovation journey. This insight led to the following research objective:

- **Objective 2**: To identify and critically reflect on theories of environmental innovation with specific reference to the environmental innovation journey conceptualised as a social process

Literature on that focus on the (environmental) innovation journey is outlined subsequently.

2.4.1 Environmental Innovation journey

The idea that innovation is situated and unfolds through time and space has received growing interest in recent sustainability debate (Schot and Geels, 2008). There is now therefore considerable interest in understanding how innovation unfolds in firms to improve, among other things, resource productivity, and conceptualise this as an environmental innovation journey. However, this line of research is in its infancy involving only a few studies.

One early approach draws on innovation management studies and offers insight into how the innovation journey, not necessarily environmental innovation journeys, unfolds inside firms (Van de Ven et al., 1999). The authors identify a generic pattern across many case studies to describe how an innovation journey unfolds inside a firm. In accounting for an innovation journey, Van de Ven et al. (1999) attributes an innovation with the following characteristics:

- a purposeful and concentrated effort to develop and implement a novel idea;
- involving uncertainty (e.g. technological, organizational, and market) regarding outcome of the innovation;
- entailing collective effort by many actors over time; and

- requiring additional resources other than those held by people undertaking the environmental innovation journey.

Building on these characteristics of an innovation described above, Van de Ven et al. (1999) subsequently identify a typical innovation journey. The innovation journey unfolds through discrete temporal stages from initiation and development periods, through to implementation and termination, and identifies the generating mechanisms that give rise to this process. In this way, Van de Ven et al. (1999) identify an innovation as one involving a unilinear process that proceeds (or not) from idea to implementation as shown in Figure 2.6.

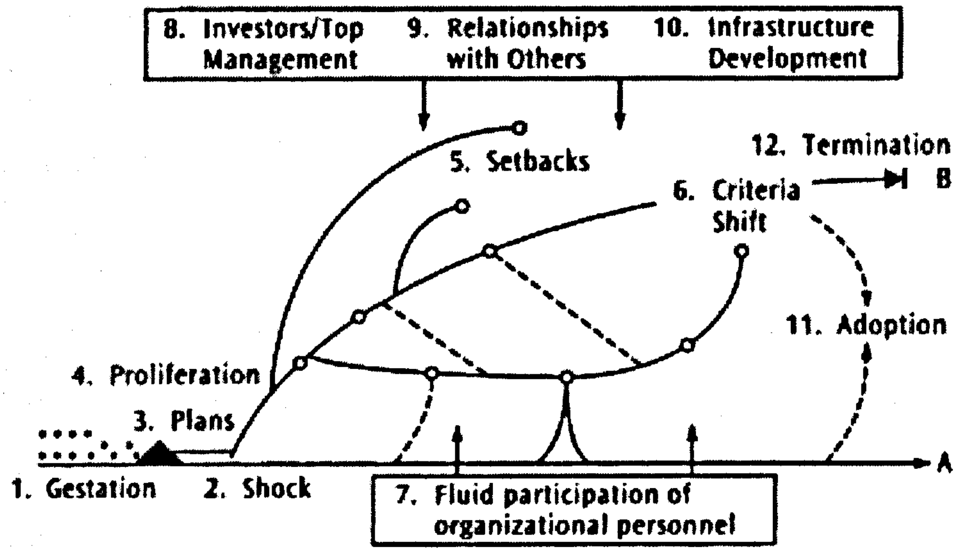

Figure 2-6: An illustration of the innovation journey
(Adopted from Van de Ven et al., 1999)

The success or failure of an innovation journey is found to be determined by distinct factors such as senior management buy-in. However, this insight does not say anything about the actual processes inside firms such as how ideas are made in a firm undertaking an innovation journey.

A different approach focuses on sustainable innovation journeys as part of transition to sustainable socio-technical system (Schot and Geels, 2008). Following Rip and Schot (2002), the emergence of novelty such as a new technology involves a process in which technology and society co-evolve into what is described as a socio-technical system. The sustainable innovation journey is here captured in the multi-level perspective (MLP), a framework rooted in the transition literature (Geels, 2002) and described in section 2.3.2. Novelty emerges in a protected niche and proceeds through alignment to wider breakthrough into a more sustainable socio-technical regime.

As noted in the earlier discussion in this chapter of the MLP, this line of research involves different levels of structuration. Shot and Geels (2008) suggest that less structured novelties emerge and are developed in protected niches, and over time proceed (or not) through alignment to wider diffusion into society in which they become embedded and contextualised. This perspective is valuable, but as noted in section 2.3.2, this focus on sustainable innovation journeys as part of a transition to a sustainable socio-technical system provides limited insight to what is going on inside firms as part of a transition. Actual processes inside firms are largely treated as a black box.

2.4.2 Identified gap in knowledge and Research question

The idea of environmental innovation journeys has received growing interest in recent sustainability debate. However, literature in this line of research is in its infancy involving only few studies with little reference to environmental innovation journeys inside firms. There is thus a gap in knowledge of how we might understand an environmental innovation journey inside a firm.

A relationship with a UK food processing firm (called the 'Firm' in this thesis) provided the researcher with an opportunity to address this gap in knowledge. Subsequently, this study therefore identifies a second gap in knowledge. Literature on environmental innovation in the UK food and farming sector is limited to studies focusing on how to promote environmental best practice in farming on the one hand, and consumer attitudes on the other (cf. Lowe et al., 2008; Pretty, 2002). However, literature on environmental innovation in this sector does not say much about this phenomenon in firms operating in the food and farming sector (Donald, 2008). Food processing firms are holding an intermediate position in the food supply chain involving relationships to, among others, farmers' food manufacturers and food retailers.

This study identifies a need to address two gaps in knowledge:

- the idea of environmental innovation journeys are situated and unfolds through time and space is an emerging field of research, but how this process might be understood inside a firm is largely absent; and
- literature on environmental innovation in the UK food and farming sector with particular reference to food processing firms is limited. The purpose of this study was therefore to explore how the environmental innovation journey unfolds in a firm from the UK food and farming sector.

This gap in knowledge was identified at the beginning of this study and led to the following research question:

- How does the environmental innovation journey unfold in a firm from the UK food and farming sector?

Considering that little is known about how environmental innovation journeys unfold in a firm, this study adopted a research perspective rather than a theory in the approach to this study. The research perspective developed in this study to address these gaps in knowledge is detailed subsequently.

2.4.3 Towards a research perspective to explore an environmental innovation journey

The literature focusing on environmental innovation in general and the environmental innovation journey in particular is found rooted in realist perspectives in social science (Guy and Shove, 2000). Problems of unsustainability such as climate change are for analytical purposes often separated from society and depicted as something 'out there' discovered by scientists. Environmental innovation is therefore understood as a social response to predefined environmental problems. The underlying assumption in realist accounts on environmental innovation is therefore one that seeks to identify how society can resolve predefined environmental problems by adding more knowledge and technologies to this end, and through deliberate shifts to move away from unsustainability (Ehrenfeldt, 2008).

Rip and Schot (2002) offer an understanding of innovation journeys involving technological change. In understanding innovation journeys as process through time and space, Rip and Schot (2002) do not deny that the emergence of novelty in the real world is complex. Nevertheless, the authors argue further that a universal theory is necessary to understand how the (environmental) innovation journey unfolds (Rip and Schot, 2002). The complexity of the real world is simplified into a stylist account: a theory that is rich enough to capture the complexity of the (environmental) innovation journey, yet simple enough to enable general application in different contexts. A typical innovation journey is therefore one that proceeds through discrete stages from innovative niche, through to alignment and wider diffusion into society.

Realist accounts of the (environmental) innovation journey therefore conceive process as a shift from one steady state to another involving progress towards predefined goals such as sustainability. The purpose of such studies is to provide policy makers and planners with an understanding of how to facilitate technological change in, for example, a firm and promote best environmental practice. The utility of understanding technological change is essential as Rip and Schot (2002) argue: innovation journeys are irreversible. Early intervention involving key actors is therefore perceived necessary so as to get it moving in the right direction, which is believed to be achieved by removing non-technical barriers to this end.

In broad terms, these non technical barriers involve:

- a lack of information or knowledge among potential actors to acquire technologies that can resolve predefined environmental problems;
- financial incentives that are insufficient to motivate investment in new 'sustainable' technologies; and
- regulatory structures that do not support technological change.

Seen this way, (environmental) innovation journeys appear as manageable and controllable processes involving the pursuit of drivers and avoidance of barriers to determine the success or failure of an environmental innovation. However, drawing on literature in sustainable architecture, Guy and Shove (2000) challenge the utility of realist accounts.

2.4.4 Constructivist critique of realist perspective

This section draws further on the critique of realist accounts described in section 2.2.5.1. Guy and Shove (2000) provide a broader critique of the realist perspective. This critique is rooted in a constructivist perspective and is essentially threefold. First, the idea that sustainability can be achieved by adding more knowledge and technologies to this end provides limited insight into how problems of unsustainability are actually made. Second, the focus on process as linear progression towards predefined goals overlooks the actual processes that unfold through time and space (Guy, 2006). Third, actual processes are replaced by underlying assumptions about agency of key actors and rational behaviour. A summary of this constructivist critique of realist perspective in social sciences is provided in table 2.2 and discussed subsequently in further detail.

Table 2-2: Summary of the constructivist critique of realist perspective (own development inspired by Guy and Shove, 2005 and Moss et al., 2005; Guy, 2006)

Realist perspective	**Constructivist critique**
Environmental problems exist out there and discovered by natural scientists	Environmental problems are constructed in scientific texts available to other actors to interpret and respond to
Focus on a unilinear model to identify intervention as to move society in desirable direction; and view process as progress of getting closer to predefined goals identified in advance such as sustainability	This builds on a means-to-an-end logic involving progressive application of science and knowledge to a predefined end, which assume irreversibility; Working towards predefined problems does not say much how problems are made
The role of social science is to identify and remove non technical barriers: environmental problems can be solved by providing more information and apply incentives and sanctions; and appear as controllable process	Assume rational choice and emphasis key actors at the expense of considering contribution of others, which put assumption of control into question
Reality is simplified in stylist account, which provide a single frame of reference: a theory that can be applied in different contexts	Lack contextual sensitivity. Reality is much more complex and messy than what stylist accounts suggests, and are therefore in danger of rather making a mess trying to describe social processes
Focus on clearer definitions and guidance how to promote best environmental practices	Ignores possibilities for multiple sustainable futures (not just one): sustainability is rather elusive concept involving competing interpretation of sustainable futures

Realist perspectives identify problems of unsustainability as something ‘out there’ and therefore separated from society for analytical purposes. Environmental innovation is therefore understood as a social response to environmental problems and illustrated as a linear progression towards predefined goals such as sustainability. The underlying assumption is that society can resolve environmental problems by adding more knowledge and technology to this end.

The principal role of social science is thus to identify and remove non-technical barriers such as more information, incentives and sanctions to encourage uptake of innovative 'sustainable' technologies. However, the unilinear model to understand social response to environmental problems is often at odds with actual social processes. Among other things, realist accounts tend to emphasises key actors' such as firms at the expense of considering contribution of other actors. Moreover, what goes on inside firms is 'black boxed, involving assumption about rational behaviour, which is often at odds with actual behaviour.

The assumption of rational choice is well established in economic theory to understand individual decision making. For example, a firm chooses among different technological options and selects those technologies that optimise their benefit such as profit. The realist perspective suggests that policy makers can influence decisions made by firms through more information and more financial incentives or creating more stringent environmental regulation and thereby 'poking' firms in a more sustainable (or desirable) direction (Sunstein and Thaler, 2008). In other words, this builds on the assumption that policy makers and planners can stimulate progress along a linear path. However, this rational choice logic does not accord with actual behaviour.

Reality is much more complex and messy than realist accounts suggest (Beveridge and Guy, 2005). Realist accounts are stylised and therefore overlook the actual processes through which environmental innovation is introduced in particular contexts. Frameworks such as the MLP overlook the complexity of actual processes and are therefore in danger of failing to understand the emergence of novelty (Law, 2004). Following Law (2004) the term 'mess' is here used in a relative sense that reality is messy and does not fit neatly in stylist accounts. Universal and stylist accounts, as explained in 2.4.3 above, therefore lack contextual sensitivity. Literature on innovation in general has failed to incorporate the 'messiness' of processes of environmental innovation and the interplay of many actors. Actual processes of interaction and negotiation through which novelties emerge in particular time and space contexts are black boxed.

Beveridge and Guy (2005) argue that there is a need to:

"look at the roles played by actors in all realms of activity- scientific, technical, social, political- touched by an innovation, and realize that it is only by following the innovation process through its twists and turns, leaps and dead ends that we can begin to understand why innovation succeeds or fails (Beveridge and Guy, 2005:673).

This constructivist approach opposes the idea of trying to find a single frame of reference, a theory to understand reality (Rorty, 1998). Instead, this constructivist approach highlights the need to uncover how innovation is made.

2.4.5 Research perspective to address identified gaps in knowledge

Following constructivist commentators in social sciences, a research perspective and not a theory was adopted in approaching this study. Guy and Shove (2000) offer an alternative approach to the realist perspective. Drawing on sustainable architecture, Guy and Shove (2000) identify multiple potential design roots for sustainable buildings. This insight is in stark contrast to the traditional debate involving reference to either light green or deep green architecture. Hence, rather than developing clearer definitions of sustainability and promote best environmental practice, the constructivist approach is an invitation to explore and even celebrate the diversity of environmental innovation

This constructivist perspective highlights the need to understand the actual process of what is going on inside a firm undertaking an environmental innovation journey. This approach accords with Guy and Moore who argue that: "*the challenge of sustainability is more a matter of local interpretation than the setting of objectives or universal goals* (Guy and Moore, 2005:1).

This constructivist approach is, however, not one criticising environmental claims; it rather follows Hannigan (1995); the purpose is to understand how environmental claims are 'created, legitimized and contested'. This means that a concept such as sustainability is rather seen as an elusive one that varies across time and space (Guy and Moore 2005). Hence, environmental problems are not 'out there' waiting to be solved, but are rather socially constructed involving local interpretations (Fisher and Hajer, 1999). Seen this way, Beveridge and Guy argue that Innovation "*is a messy process in which arrangements are built between actors to support the innovation in very specific time and space contexts*" (2005:675). In other words, in accounting for how environmental innovation is made needs to take into account what is actually going on in particular time and space contexts.

The research question underpinning this study '*how does the environmental innovation journey unfold inside a firm*?' is therefore valid. However, to study this process we need to conceptualise it in order to account for it. This study follows Beveridge and Guy (2005) and more recently Oak (2010). The environmental innovation journey can usefully be conceptualised as a social process. In this social process, environmental innovation journeys are situated in time and space and are travelling through these. Environmental problems and solutions are constructed by actors involved as they go along: the environmental innovation journey therefore consists of participants who interact and negotiate to create something new to resolve environmental problems.

This study follows this constructivist perspective to explore the environmental innovation journey in a firm from the UK food and farming sector. This initial analysis in light of the research question led to the following research objective being identified:

- **Research Objective 3:** To identify and critically reflect on the environmental innovation journey conceptualised as a social process involving the construction of environmental problems and solutions

This study therefore set out to explore an account of the environmental innovation journey following this constructivist perspective. Research methods developed in this study to explore an account of the environmental innovation journey are the subject of the following chapter.

3 Method

This chapter focuses on the method developed in this study to explore an environmental innovation journey. This chapter on method contains three sections. The first section draws on literature on method and identifies a research design to address the gap in knowledge described in section 2.4.2. A flexible research design is explained and justified. Second, the application of research design throughout this study is described. Third, how sense making was achieved of the environmental innovation journey. A summary of key notes of this chapter is detailed in the textbox below.

3.1 Introduction to research design	The introduction identifies a flexible research design selected for this study to explore the environmental innovation journey, conceptualised as a social process, involving the construction of environmental problems and solutions. Ethnographic case study involving participant observation and semi-structured interviews was selected to collect data. A template approach based on analytical categories found in literature was selected to make sense of data and develop a representation from this case study
3.2 Application of research design	The application of research design describes how data was collected and analysed in this study.
3.3 Making sense	This section describes the research funnel and provides details about the aim and the objectives met throughout this study.
3.4 Research limitations	This section provides a summary of the limitations of this study. Research limitations are discussed in terms of data collection, data analysis and contribution to knowledge.

3.1 Introduction to research design

Following Robson (2011), a research design should usefully include reference to the following aspects of the research process:

- the purpose of the study;
- theory or theories identified to inform the study;
- the research questions;
- method to collect data; and
- data analysis to provide an answer to those research questions identified.

Anastas and MacDonald (1994) distinguish between two types of research design in social science, which are fixed research designs and flexible research designs. The principal difference between these types of research designs is the level of preparation required by the researcher.

Studies that select a fixed research design require a number of pre-specifications established by the researcher at the beginning of the research process such as research question and method to collect and analyse data. In fixed research design, data are principally in forms of numbers and refer to a quantitative research strategy. This approach is useful when the researcher knows what to look for, which is often informed by a conceptual framework, and know how to collect and analyse data, which is prescribed in selected methods.

In contrast, flexible research designs is useful in exploratory research and require, in comparison to fixed research design, less preparation by the researcher prior to data collection and analysis. This approach is useful for situations in which theory is underdeveloped and therefore provides little guidance to the researcher what to look for. In the flexible research approach these aspects of the research process (i.e. the purpose of the study, theory, research question and method for data collection and analysis) evolve throughout the study. A flexible research approach is usefully designed to change as the study unfolds. Data in flexible research design are principally in forms of words and refers to a qualitative research strategy.

The purpose of the study decides the research design. In Robson (2011) research purposes can be classified into descriptive, explanatory and exploratory. These classifications are detailed in bullet points below.

- **Descriptive:** a descriptive purpose involves those studies that try to illustrate what is happening in a particular situation and aims to provide an accurate description. A good understanding of the situation the study is set out to describe is necessary. Both fixed and flexible design may apply.
- **Explanatory**: a study that seeks an explanation of a situation or problem is explanatory. The focus is traditionally to identify causal relationships between aspects of the phenomenon the study is set out to investigate and explain patterns relating to the phenomenon. Both fixed and flexible design may apply.
- **Exploratory:** a study that is set out to explore what is happening in a situation that is poorly understood is exploratory. The purpose is to seek new insight. This can be achieved by asking questions and assessing a phenomenon in a new light. Primarily flexible design may apply.

From the discussion and analysis in Chapter 2, this study is rooted in a constructivist perspective in social science. The purpose of this study is to explore an account of the environmental innovation journey in a firm from the UK food and farming sector. A flexible research design has therefore been developed in this study to address identified gaps in knowledge. The principal advantage of this flexible research design is (1) the exploratory approach to generate new insights in a situation that is poorly understood, and (2) the flexibility in research design to change design as the study proceeds.

3.1.1 The role of theory in flexible research design

A theory typically refers to an explanation or understanding to what is going on in a situation that is being studied. A theory identifies ways of knowing the world: what there is and how it works. A theory can be captured in a conceptual framework, which here refers to a representation of reality. The role of theory in a flexible research design-approach is different from a study built around a fixed design.

In fixed research design, conceptual frameworks are selected prior to data collection and inform the researcher what to look for throughout the study. Fixed research design is therefore useful to verify theory. In contrast, studies that follow a flexible design do not select theory prior to data collection. Flexible research design lends itself to produce new theory or generate new insights.

The purpose of this study was not to verify theory, nor was it to produce new theory. Instead, insight from literature informed data collection and aided sense making throughout this exploratory study. This approach follows Hammersley and Atkinson (1995) and is described as the 'progressive funnel' approach. Insight from literature informs the researcher what data to look for and aid sense making. The progressive funnel follows an iterative process in which literature review, data collection and data analysis is refined as the study proceeds.

In this approach, those conceptual frameworks identified in literature that accord with data collected in the study are selected to aid sense making. Conceptual frameworks are here selected to help the researcher make sense of data (interpretation) and develop a representation from the study. This approach accords with Law (2004); it is a representation of reality produced in research undertaken in the real world, and is always incomplete. However, this does not mean that conceptual frameworks are not useful as argued by Cillers (2002) 'we need limits in order to say something'.

A conceptual framework usefully identifies what there is in the real world that is meaningful and useful to bring into presence. This also means that some things are made absent and not accounted for. The role of theory and conceptual frameworks therefore requires careful consideration. This is because conceptual frameworks can help the researcher to see certain things while making the researcher blind to other things. Hence, a theory was not selected prior to this study.

As noted in Chapter 2, a research perspective informed by constructivist commentators in social science was identified as appropriate for this study. Theories, concepts and ideas on environmental innovation in general and the environmental innovation journey in particular were explored throughout this study to aid sense making. Hence, insight from literature informed data collection and data analysis. The following section explains and justifies approach to data collection.

3.1.2 Approach to data collection in flexible design

This study set out to explore the environmental innovation journey in a firm from the UK food and farming sector. A flexible research design was selected for this purpose. The principal advantage of this approach was the opportunity it presented to identify methods for data collection early in the study, which were then refined as the study proceeded. In studies that follow a flexible research design, Cresswell (1998) distinguishes between three approaches to data collection. These are:

Ethnography

A different approach to collect data in a flexible research design is an ethnographic method. This research tradition originates from the anthropological involving studies focusing on the culture and social structure of a social group such as a tribe that is poorly understood by the researcher. The typical focus in such studies is to understand the life in the community. Neyland (2008) defined ethnographic as a method *"which involves the observation of and participation in particular groupings"* (Neyland, 2008, p.1)

The researcher should therefore engage with the social setting and participate in the day-to-day life of the community (Davidson and Layder, 1994). This position of the researcher usefully enables the researcher to see and account for social actions and interactions in the social setting. Data collection and analysis in this approach is reflected in the term ethnography, which means 'people writing' and can also be referred to human geography. Seen this way, ethnography can also be defined as an outcome (Watson, 2011). Watson defines ethnography as a *"style of social science writing which draws upon the writer's close observation of and involvement with people in a particular social setting and relates* *the words spoken and the practices observed or experienced to the overall cultural framework within which they occurred (Watson, 2011, p. 207).*

The advantage of this ethnographic approach is twofold. First, the intended outcome of ethnographic studies is to provide a detailed 'thick' description of the life in the social community (Watson, 2010; Geertz, 1973). An ethnographic approach is therefore useful to gain insight to situations that are poorly understood by the researcher. Secondly, while ethnography is an outcome, it allows the use of a wide range of methods (Watson, 2011).

This ethnographic approach enables the researcher to uncover and explicate what is going on in the situation the study is set out to explore (Van Maanen, 1975). This ethnographic approach has been applied in more recent studies to explore communities in urban society (Bogdan and Biklen), and how knowledge is produced in laboratories (Latour and Woolgar, 1979).

Grounded theory:

Grounded theory can be described as a dynamic interplay of data collection and analysis (Payne, 2007). Relevant literature is considered in light of data collected through initial research. This means that literature is selected subsequently so as to aid sense making. The advantage of this approach is that key literatures may not be known prior to data collection, but rather emerge through interplay between data collection and analysis (Glaser, 1998). Aspects of grounded theory approach were used in this study. However, data were reviewed simultaneously with data collection.

Case study

A third tradition in research that follows flexible design is case study. This research strategy can be applied in any study that seeks to find out more about a particular situation such as a firm, a city or an innovation (Robson, 2002). In Yin (1994), case study is defined as: *"a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence"* (Yin, 1994, p: 10). Following Goetz and Le Comple (1984) and Fetterman (1989), an ethnographic approach can usefully be combined with case study.

The principal advantage of a case study approach is the opportunity it presents to use multiple methods for data collection and analysis. Thus a case study approach lends itself usefully to this study to undertake empirical research in the Firm. Here, the Firm situated in the UK food and farming sector provides the particular context of this study. This context put useful boundaries of this study to explore the environmental innovation journey conceptualised as a social process. The Firm and research context is presented in chapter 4.

Ethnographic case study

In this flexible design an ethnographic case study was developed to collect and analyse a variety of data. The advantage of this ethnographic case study is the opportunity it presents the researcher to engage and participate on the work on environmental innovation in the Firm as and where it actually unfolds. Data collection via ethnographic methods has been principally carried out inside the social setting of the Firm to explore social action where it actually takes place. However, this ethnographic approach to collect and analyse data does not offer any detailed guidelines how to achieve this. Instead, inspiration from other ethnographic studies was consulted for this study.

This ethnographic case study offered an opportunity to use mixed methods to collect and analyse data, while reviewing literature simultaneously. The methods identified for data collection following this flexible design approach are outlined in the following sub-section.

3.1.3 Methods identified for data collection in this ethnographic case study

An ethnographic case study approach does not include a formula of routinized procedures to collect and analyse data. Ethnography is rather an approach (a research strategy) that lends itself usefully to exploring a situation that is poorly understood and to generate new insights. The social setting in this study is the Firm situated in the UK food and farming sector.

The principal advantage of this ethnographic case study for collecting data is that it enables the researcher to use mixed methods. Selecting methods for data collection depends on what the study seeks to explore, which decides what kind of information, from whom and under what circumstances data are collected (Robson, 2002). In a flexible research design, research questions are usefully flexible and open-ended in the early stage of the study and refined as necessary as the study proceeds. Ethnographic methods for data collection are principally interviewing and observations. These two methods are discussed in turn below.

3.1.3.1 Interviewing

Interviewing is a method for data collection that involves asking people questions about the situation the study is seeking to explore. There are different ways to pursue an interview. Robson (2002) distinguish between three types of interviews with particular reference to structure, these are structured, semi-structured and unstructured forms of interviews.

- **The structured interview** involves a set of predetermined questions identified by the researcher. This approach is useful in situations when the researcher knows what to look for, which is typically informed by theory and conceptual frameworks.
- **The semi-structured interview** involves, similar to structured interviews, a set of prepared questions, however, with the difference that those questions selected by the researcher are flexible and open-ended. This approach is useful in situations when the researcher is interested in a particular phenomenon without having identified a conceptual framework to account for this.
- **The unstructured interview** is one that does not involve any questions prepared by the researcher. The interview rather unfolds through the conversation. This approach is useful in those situations where theory is absent and the purpose of the study is to produce theory

3.1.3.2 Observational methods for data collection

Observational methods involve some form of direct observation of what is going on in the situation the study is setting out to explore (Robson, 2011). This method can be used in a fixed design, in which observations are structured, and in flexible designs involving participant observations. The latter was of interest in this study following the flexible research design selected. In principle, participant observation (PO) requires the researcher to become engaged in the social setting and share their life experience. The position of the researcher and relationship with other participants in the social setting is therefore important to the outcome of the study.

In Robson (2002) a continuum of three distinct approaches to participant observation is identified:

- **The complete participant**: In this approach the researcher conceals the purpose of the study from other participants in the social setting. The researcher rather seeks to become fully engaged in the situation of the study by becoming a full worthy member. The advantage of this approach is in those situations in which other participants are unwilling to cooperate with the study if the purpose was revealed to them (cf. Clarke, 1996). However, this approach has ethical implications as other participants can feel deceived.

- **The participant as observer**: In this approach, the role of the researcher as observer is made clear to the social setting at the start of the study. The researcher seeks to establish relationships with the other participants in the social setting and engage with their activities. In this way it is possible for the researcher to gain insight to the social setting and share their experience by participating in the day-to-day life. The relationship with other participants and becoming a trust worthy member of the social setting is therefore important in this approach to make data collection work. In this position, the researcher can bring new aspects to the situation the study is set out to explore for example by evoking particular behaviour. However, situations created by the researcher can involve a danger of artificiality: other participants agree to do something to please the researcher.

- **The marginal participant**: In this approach the role of observer involves a lower degree of participation in comparison to those positions described above. The researcher can undertake a passive role in the social setting, while still be fully accepted by other participants such as observing other passengers on a bus. Although the purpose of the study is unknown to other participants, the presence of the researcher requires careful reflection throughout the study. The ability of the researcher to 'blend in' without diverting from what can be seen by other participants as normal behaviour is therefore important. For example, observing children's playground may usefully require the researcher to bring a child to this social setting to avoid intimidation amongst other participants (Zeisel, 1984).

The principal advantage of participant observation, regardless of the position of the researcher, is the opportunity it presents to observe what is going on in the social setting they are involved. This approach to data collection can therefore usefully complement other methods such as interviews (Robson, 2002). Rather than asking other participants specifically what they think in relation to a particular situation, participant observations involves both watching and listening to account for what other participants say and do. Participant observation is therefore useful to gain insight to a situation that is new to the researcher and to acquire a rich and detailed picture of the situation throughout the study (Geertz, 1973).

Methods for data collection	Ethnographic case study involving semi-structured interviews and participant observation

3.1.4 Approach to data analysis in ethnographic case study

Data collected in this study followed a flexible research design involving ethnographic methods of participant observation and interviews, with data primarily in the form of words. This qualitative research approach focuses on an account that is 'rich', 'full' and 'real' (Robson, 2011), and is described as 'attractive nuisance' (Miles, 1979), in contrast to those thin abstractions of numbers presented in quantitative research.

Methods for qualitative data analysis concentrate on making interpretation of data in order rather than following a tight prescription. How data is interpreted depends on the approach selected by the researcher to analyse data. Advocates of qualitative data analysis (Tesch, 1990; Crabtree and Miller, 1992; and Drisko, 2000) identify four distinct approaches:

- **The quasi-statistical approach** emphasises the frequency of words or phrases used in a social setting and identify those by undertaking content analysis. This approach can be used to convert qualitative data into a quantitative representation to determine the relative importance of terms and concepts.
- **The template approach** involves analytical categories selected by the researcher and emphasises key codes that guides the researcher what to look for. The codes can be selected in different ways: (1) codes selected prior to data collection and analysis are typically identified in conceptual frameworks or research question; (2) codes can be developed throughout the study derived from data in those situations theory is absent; and (3) codes can develop in combination of conceptual framework identified in literature and data collected in the situation the study is set out to explore. The codes serves as templates or 'bins', which can usefully change as the study proceeds. A matrix analysis is common in this template approach to capture descriptive summaries of text into matrices or diagram.
- **The editing approach** emphasises the interpretation made by the researcher. Codes are therefore not appropriate at the beginning of the study, but rather emerge as outcome of the study. This approach is useful in those situations under study where theory is absent such as the grounded theory approach.
- **The immersion approaches** emphasises the researchers insight and intuition of what is going on in a social setting. For example an artist that provides a reflective account of a painting. The analysis in this approach is therefore not systematized, but rather

relies on the knowledge and creativity of the researcher and the reception of research audience.

Approach to data analysis is determined by what the study is trying to find out and research design selected. The flexible design selected in this study involving an ethnographic approach is open to template or editing methods to data analysis. The editing approach was not found useful because a research perspective rooted in literature on environmental innovation inspired by constructivist commentators in social science informed the researcher to some extent prior to data collection. Rather, a template approach was found useful to analyse data in this study. The principal advantage of this template approach is the emphasis on systematic analysis of data.

The purpose of data analysis in flexible research design is to make an interpretation of the situation the study is set out to explore. Here, interpretation involves the researcher's ability to process information in a meaningful and useful manner (Fetterman, 1989), and provide a representation that is convincing. To achieve a convincing representation from this ethnographic case study, a template approach was selected to analyse data. Moreover, a discourse analysis was subsequently usefully identified in this study.

The approaches undertaken in this ethnographic case study to develop a representation followed an iterative process involving literature review, data collection and data analysis. The advantage of this approach is the opportunity it presents the researcher to become progressively focused as the study proceeds (Hammersley and Atkinson, 1995). Here, progressive focusing refers to the way literature review informed data collection and analysis, which stimulated further literature review, data collection and analysis.

3.1.4.1 Template approach

Following Miles and Huberman (1994) data analysis consists of three interlinked research activities: data reduction, data display and drawing conclusions. Data reduction involves a process of reducing large amount of data into something that is manageable. The use of codes here serves as analytical 'bins' to organise text. Codes can be identified in (1) theory prior to data collection and analysis; (2) from data that results in codes, and (3) from a combination of theory and data collected throughout the study. The third option was selected in this study. The situation is that theory of environmental innovation exits in literature, but particular reference to the environmental innovation journey is underdeveloped.

Data display and drawing conclusions follows iteratively from data reduction. Data display is about presenting data, and drawing conclusions involves a reflection of what the data has to say. However, there is always a danger of deficiencies in this approach. Sadler (1981) identifies the following limitations in making interpretations of qualitative data: (1) data overload limits the amount of data the researcher possibly can process; (2) first impressions can lead to misleading interpretations as the study unfolds; (3) information availability - the researcher can only account for information obtained, while information that is difficult to get hold of gets less attention, and (4) positive instances involves the danger of ignoring information that is in conflict with other data collected. How this approach to data analysis was applied in this study is described in section 3.4.

3.1.4.2 Discourse Analysis

Discourse Analysis (DA) was identified as a useful approach to make sense of the environmental innovation journey. However, it was only at the end of this study that it was found necessary to pursue DA. A short introduction to DA is therefore provided in this chapter, and more detail is provided in chapter 7.

Discourse analysis is a method to understand how discourses affect social change such as environmental policy and planning (Sharp and Richardsson, 2001). However, DA involves many different approaches and how this method is used is therefore determined by the researcher's understanding of discourse. A broad distinction identifies foucauldian and non-foucauldien type of DA (Fiendt and Oles, 2006). While the latter focuses on language and its use, the former focus on knowledge. In this study it was found useful to explore how claims to knowledge regarding environmental problems and solutions was produced and legitimised or delegitimized over time. A foucauldian approach to DA was pursued in this study to account for competing environmental discourses found in the Firm.

Data analysis in studies with flexible design seek to make sense of the phenomenon studied. To achieve this, studies can usefully follow a **progressive funnel approach**. Here, conceptual frameworks identified in literature, data collection and data analysis are intertwined. A **template approach** was selected to aid sense making. An analytical template consists of concepts found in literature that accord with data collected throughout the study. Making sense of data in this way includes three interlinked research activities (1) data reduction, (2) data display and (3) drawing conclusions.

3.1.5 Summary: research design

A flexible research design was selected to explore how an environmental innovation journey, conceptualised as a social process, unfolds and make sense of this process. The principal advantage of this flexible design was the opportunity it presented to change research designs as the study proceeded. This included refinements of the research question, theory, and the method for data collection and analysis could be identified as necessary as the study unfolded.

The purpose of this study was to explore a situation in which literature is limited but not absent. Hence, data were usefully collected early in this study. The approach to data collection was the use of an ethnographic case study. The principal advantage of this approach is the opportunity it presents to explore what is going on in the situation selected by the researcher and to use mixed methods for data collection.

The methods identified to collect data were interviews, observations and action research. Interviews involved asking people involved in the case study situation to explore their views. Observations involves watching people working, what they say and do. Action research could be applied to influence a particular practice with the purpose to generate an understanding of the situation while trying to improve it.

This flexible research design lends itself exclusively to qualitative data in the form of words. The approach to data analysis selected in this study was the template approach. The principal advantage of this approach is the opportunity it presents to systematically make sense of data to produce a representation. A representation involves the researcher's interpretation of the case study situation. To achieve this, an interlinked process involving data reduction, data display and drawing conclusion was identified.

3.2 Application of the research design

This study set out to explore how an environmental innovation journey actually unfolded in a firm situated in the UK food and farming sector. Following constructivist commentators in social sciences, a broad and simple perspective was established to explore this and generate new insights to environmental innovation. In this perspective the environmental innovation journey was conceptualised as a social process involving the social construction of environmental problems and solutions.

A flexible design was developed in approaching this study. The way this study developed is usefully described as a progressive funnel in which data collection, literature review and data analysis developed simultaneously. Insights from literature informed the researcher what to look for and to make sense from case study. Data were therefore collected from the beginning of this study. The application of this research design is described subsequently in three sub-sections.

3.2.1 Data collection

Data collection in this ethnographic case study involved mixed methods. Data were collected in this study using ethnographic methods of participant observation and semi-structured interviews. How data were collected using these two methods are described below.

3.2.1.1 Participant observation

Data collected by the researcher as insider doing participant observation occurred frequently during this study. The researcher participated in the Firm's environmental innovation journey: between October 2008 until October 2011. However, this approach, involving the researcher as insider doing participant observation, changed over time in terms of the frequency of visits to the Firm and the position of the researcher. An overview of how participant observation was applied throughout this study is provided in table 3.1.

Table 3-1: Participant as observer applied in this study

Time	Average frequency	Research position
October 2008 to December 2009:	3-4 days per week	Participant as observer situated inside the Firm
January 2010 to October 2010	2-3 days per week	Participant as observer situated inside the Firm
November 2010 to October 2011	Once per month	Participant as observer situated outside the Firm

The researcher's relationship with the Firm began as an insider participant-as-observer. The role of the researcher as observer in this approach was revealed to other participants. Making the purpose of the study and the role of the researcher clear to other people in the social setting was found necessary for the researcher to become a trustworthy member of the Firm. This was also found important for ethical reasons to avoid other participants feeling deceived if the researcher concealed the purpose of the study. Hence, the role of the researcher and the purpose of the study were clarified with members in the Firm at the beginning of this study (cf. Appendix D on research ethics). This involved a formal contract between the Firm and the University, and included an invitation to the researcher to participate in the work on the Firm's corporate environmental strategy.

Data collected by the researcher as insider doing participant observation involved a reflective diary. This reflective diary was used as recording device to capture the researcher's experience from the Firm (cf. chapter 5). The researcher engaged in activities in the Firm and participated in meetings and observed operational processes such as food processing. Observations were captured as memory notes on a daily basis. The memory notes usefully captured those things that the researcher found interesting. Here, data collected from observations was condensed to text in the diary and organised across time. Each diary entry began with date and the following prompts underpinned memory notes:

- What is going on here, what is happening?
- Why is this happening; and what does it mean?

This reflective diary therefore reflects those particular situations observed by the researcher. Many participants, organisations and technologies that are specific to this case study were accounted for. A list and description of these specifics are provided in Appendix C.

In this flexible research design, literature review, data collection and analysis were intertwined throughout this study. Observations made in the Firm were therefore captured and reflected upon in light of literature on environmental innovation with particular reference to the environmental innovation journey. However, it was not possible to identify a way to account for this process at the beginning of this study. The researcher rather began exploring the environmental innovation journey using participant observation, while data were captured in the reflective diary. The research perspective became gradually more focused as the study unfolded.

The reflective diary adopted in this study was therefore not structured involving a particular format. However, data collected using the reflective diary became gradually more focused as the study proceeded.

3.2.1.2 Semi-structured interviews

Interviews were undertaken throughout this study to collect data from key informants in the Firm. The purpose of interviewing was to collect useful information from people that had a good understanding about the case study situation. In this study, interviews were conducted with people who could provide useful information focusing on the environmental innovation journey. Here, interviews were conducted for a purpose. However, as the outcome of this study was not decided prior to interviews, a semi-structured format for interviewing was therefore selected.

In this semi-structured approach to interviewing, questions were prepared by the researcher. The interview questions were exploratory and open-ended. This meant that questions were prompted by the researcher but open to interpretation by the respondent. The purpose of this was to gain insight to what the respondent thought around particular topics selected by the researcher. The topic in this study was the environmental innovation journey and interview questions reflected on this. Typical interview question used in this study were:

- What is your role in the Firm?
- What environmental problems are facing the Firm or this sector?
- Why these environmental problems?
- How do you think the Firm should resolve those problems you identified?
- What is the motivation to resolve these problems?

Interviews were conducted throughout this study with different people. Those people selected in the Firm for interviews were identified by the researcher as key informants. A 'key informant' is an individual in the Firm that was found to have a particular views or information that can be useful for this study. Participant observation was therefore useful compliment to semi-structured interviews. Insight generated from participant observation identified key informants throughout this study.

Questions prepared by the researcher were those most useful to ask at the time of the interview and in relation to the respondent. The respondent was informed prior to the interview about the purpose of the study and the role of the researcher. This helped gain trust and avoided ethical implications. The role of the researcher in semi-structured interviews is to ask questions, however, without leading the respondent in a particular direction. Secondly, the researcher needed to listen carefully to what the respondent had to say. This is important in exploratory research to gain insight that cannot be foreseen.

Details about interviews carried out in this study are provided in appendix B with reference to information about key informants.

3.2.2 Data analysis

Data was analysed to produce a representation from this ethnographic case study that makes sense of an environmental innovation journey in a firm. Sense making refers to the idea that research can produce an interpretation of reality. This means that reality cannot be accounted for in its full complexity, but we can say something about reality to provide key insights and make a contribution to knowledge. Hence, this study presents the researcher's interpretation of reality of what went on in the case study Firm.

A representation of key insights can be thought of as a mirror that reflects reality and highlights key features of that reality. However, this representation represents a partial view of reality, which is that of the Researcher. Hence, the outcome of this study could have been something else if someone else, e.g. another participant in the Firm, had reflected on what went on in the Firm. The Researcher and author of this account in this thesis focused on environmental innovation in general and how such process unfolds in particular.

A template approach to data analysis was developed for this purpose. The template was constructed from analytical categories found in literature and identified by the researcher in light of data collected in the Firm. These analytical categories served to organise data collected throughout this study. Following the flexible design research approach, the analytical categories were refined as the study developed.

The template approach to data analysis in this study involved two interrelated processes (1) a progressive funnel involving literature review, data collection and data analysis to identify analytical template, and (2) making sense of data using the template.

The first process, the progressive funnel, stimulated the focus of this study. Insight from literature informed data collection and analysis, which became progressively more focused as the study developed. The progressive funnel inspired the development of the template as interpretive frameworks to aid sense making. The analytical categories identified in this study developed from literature in light of data collected in the Firm. Literature that accords with data collected in the Firm was selected to develop an interpretive framework to make sense of an environmental innovation journey.

Second, making sense of data involved a process of developing a representation from case study so as to generate meaningful and useful insight about an environmental innovation journey. An interpretive framework was developed from literature as template to process information collected in the Firm. A blank version of an interpretive framework is provided in Table 3.2.

Table 3-2: Blank version of an interpretive framework

Analytical categories	Description
Concept A	Description of concept A
Concept B	Description of concept B

Following Miles and Huberman (1994) an iterative process involving three interlinked activities was pursued to make sense of data in this template approach: data reduction, data display and drawing conclusions.

- Data were reduced with help from template involving analytical bins to organise data collected throughout the study
- Data were displayed and presented as text and tables
- Conclusions were drawn from data involving reflective insights from data in light of the template inspired by literature

Having described the application of the research design selected for this study, the following section provides details how sense making was achieved.

3.3 Making sense of the environmental innovation journey

The aim of this study was to explore how the environmental innovation journey, conceptualised as a social process, unfolds in a firm from the UK food and farming sector and to identify ways to account for this process. This study identified three ways of making sense of an environmental innovation journey using different analytical templates inspired by literature on environmental innovation. How sense making of an environmental innovation journey developed in this study is described below with reference to the following three analytical perspectives:

- First, the environmental innovation journey as a social process involving the construction of environmental problems and solutions.
- Second, the environmental innovation journey constructed as social practices.
- Third, the environmental innovation journey conceptualised as social practices involving competing environmental discourses.

A summary of the research funnel is provided subsequently to describe how this study developed.

3.3.1 The process of data analysis

This section provides details of the process of data analysis. This is best described as a progressive funnel involving an iterative process. This progressive funnel, described in chapter 1, refers to the way this study became gradually more focused. This means that a broad and open-ended research question was identified at the beginning of this study, which was:

- How does the environmental innovation journey unfold in a firm from the UK food and farming sector?

A research perspective was developed to account for the environmental innovation journey conceptualised as social process. This perspective was informed by literature rooted in constructivist perspective in social sciences. Research methods were selected to explore the environmental innovation journey, conceptualised as a social process, and to provide new insights as to how this process can be accounted for.

Data were collected via ethnographic methods e.g. participant observation and semi-structured interviews. A reflective diary was used to capture events in the Firm and to reflect on these events in light of theories of environmental innovation found in literature. Semi-structured interviews were conducted so as to collect data from key participants and their views on environmental problems and solutions associated with the Firm.

At this early stage of the research process, the Researcher did not see the outcome of this study. This means that data collection in the Firm via ethnographic methods were broad and open-ended. A critical reflection of events observed in the Firm in light of relevant theories of environmental innovation found in literature produced key insights. This was achieved during the research involving an iterative process.

This iterative process involved data collection, analysis and literature review. The researcher drew on literature on environmental innovation and identified categories so as to aid sense making. These categories were then translated into an interpretive framework. Three interpretive frameworks were developed in this study. An over view of these are provided in section 3.3.1, 3.3.2 and 3.3.3. These frameworks were not taken 'of the shelf' but were rather developed from literature in light of data collected in the Firm.

The first interpretive framework, presented in section 3.3.1 and chapter 5, was developed from initial research. This framework was used to account for the environmental innovation journey conceptualised as social process involving the construction of environmental problems and solutions. A time line was developed to organise data around the identified categories (i.e. situation, environmental problem, solution, key participants and their motivations). The raw data consisted of memory notes collected in the reflective diary. An extract from this diary is shown below. These memory notes, depicted in textbox below, show events observed with reference to end-of-pipe in the Firm.

- ***December 11th 2008,*** *"The water treatment engineer is concerned with the plant (water treatment plant), because it has been working at its upper level of capacity for a long time.*
- ***January 12th2009,*** *a meeting with Water Treatment Consultant regarding a project to introduce a probe to measure Dissolved Oxygen in the plant. This solution is believed to provide a reduction in aeration energy cost with 50%. This solution can be used to show progress in the work on the Environmental Strategy e.g. how the Firm address a key environmental challenge in food production.*
- ***January 14th*** *the Project Engineer argues that the management and operational procedures regarding the water treatment plant needs to be clarified. At this point, they are fire fighting rather than maintaining and preventing problems to make it run smoothly.*
- ***January 20th2009,*** *a project initiated in the engineering department seeks to identify factors that affect the performance of the water treatment plant; how to measure, monitor and control this process so as to achieve improvements of its performance.*
- ***January 30th2009,*** *the Water Treatment Engineer argues that they need a Sartorius, which is a kind of monitoring equipment. This will enable operators to measure percentage of solids in the wastewater (MLSS).*
- *Today, a visitor from the EA (the Environment Agency) is coming to sample water discharged by the Firm and analyse its quality. I think this is something that happens every month. The Water Treatment Engineer is a little worried because the plant was struggling in December and because of this cold winter the bacterial culture in SBR 2 is not performing as normal.*

Notes in the reflective diary were analysed and organised in a matrix. Table 3.3 show an example of how events were captured in this initial data analysis.

Table 3-3: An example of data analysis focusing on the environmental innovation journey conceptualised as a social process

Environmental problem	**Environmental Solution**	**Motivation**	**The main participants**
Water effluents that arise from water used in production	Water treatment plant	Compliance with the water discharge license	The Water Engineer, the Project Engineer Manager, the EA representative, the Water Treatment Consultant

The raw data collected in the Firm were mapped onto a time line. This means that time was used in a relative sense in relation to events observed in the Firm. Key events were reduced to stories reflecting a particular time in the Firm when a particular environmental problem and solution was pursued. Key participants and their motivations were accounted for in light of these events. This initial analysis is provided in chapter 5 and shows that the environmental innovation journey is much more messy and complex than realist 'clean' accounts suggest. However, this insight did not offer a satisfying response to the research question posed. In contrast, this initial analysis identified key characteristics of the environmental innovation journey and stimulated further research.

The research question was refined and the study became more focused. The focus of this study changed from '*how does the environmental innovation journey unfold in this firm*' to a focus on '*how to make sense of the environmental innovation journey without making a mess accounting for it*'. Following this insight it was found necessary to explore literature outside the traditional domain of environmental innovation theory.

A critical review of literature identified theories of practice. A recent study drew on theories of practice to account for innovation and change. This practice approach was found valid and useful and therefore adopted in this study. However, while studies that draw on theories of practice to account for innovation tend to focus on distinct practices in terms of what people do (e.g. cycling) this study focused on practices in this Firm. Practices in the Firm are multiple and interlinked. This stimulated development of research objective 4:

- To identify and critically reflect on the environmental innovation journey conceptualised as social practices.

Drawing on theories of practice altered the process of analysing the environmental innovation journey. A second interpretive framework was developed. This framework was inspired by other studies that draw on theories of practice. However, it was found necessary to develop this framework in light of data collected in the Firm. Three categories were identified: participants, images and technologies, to account for practices. In addition to this framework, four processes were identified from literature to account for how practices change. These are (1) new practices can emerge, (2) practices can persist, (3) practices can disappear, and (4) a change in one practice can affect other practices. Table 3.4 shows an example of how this analysis translated an event (see table 3.3) observed in the Firm into practices.

Table 3-4: An example of a practice accounted for in this analysis

Situation	Main participants	Images of Performances	Technologies
October 2008 to October 2011	Insiders: Engineers, Environment Officer, FM 1 and 2 Outsiders The Environment Agency	Water treatment capacity in relation to effluent water arising in production	Water treatment plant and associated infrastructures; devices for solid waste removal and disposal; environmental regulation frameworks

Following this conception and associated processes, data collection and analysis became focused on social practices. This means that additional data collected in the Firm focused on these three categories and the four associated processes. Data collected in the Firm prior to the time that the idea of social practices was adopted in this study and data collected following this insight was analysed in light of this framework in chapter 6. This means that chapter 5 provide a narrative of the environmental innovation journey conceptualised as a social process. This representation was then reduced in chapter 6 so as to focus on social practices.

This means that the method for data analysis did not change, but the understanding of the environmental innovation journey changed. The representation in chapter 6 was achieved by translating events accounted for in chapter 5 into developments of practices in the Firm, which is described in chapter 6. A template approach was used to organise data into a matrix as depicted in table 3.4. This analysis, provided in chapter 6, shows how practices persist, how people in the Firm tried to develop new practices, how practices disappeared, and how change in one practice can affect other practices. However, this analysis did not show what shaped practices in the Firm.

A third interpretive framework was developed to account for competing environmental discourses. The idea that discourses are important to account for to understand how practices change was identified by the end of this study. Hence, data collected in the Firm prior to the time that this insight emerged in this study was used to account for competing environmental discourses. This includes data collected via semi-structured interviews as well as memory notes in the reflective diary. This means that the data used in this discourse analysis included data collected in this study that was not collected with the concept of discourse in mind. An extract from an interview with the Water Treatment Engineer in Mars 2010 is depicted in textbox below.

Water Treatment Engineer: *we (the treatment plant) spend about 25% of the total energy consumption of the factory*

Researcher: *Are there any ways to improve that?*

Water Treatment Engineer: *Yes, there are a few projects that we are looking at, dissolve oxygen in the tanks, which reduce the amount of electricity used to aerate the tanks. We have done one thing, and that is, we have replaced 10 (water) pumps into 2, which save us in terms of labour. We are looking into more efficient motors and stuff like that, but this stuff is more expensive, so we can't spend money on that equipment really.*

Researcher: *Are there any alternative ways or means to deal with water and waste management?*

Water Treatment Engineer: *In terms of waste we have looked in to anaerobic digestion, but we don't produce enough waste to make it viable. We started to use the waste centrifuge more efficient now so the actual waste we produce is drier and contains less weight, which means les trips. This saves them fuel, it doesn't save us anything. There was another option with the onion waste; the actual onion waste is large volumes and small weight. There is a system out there that can compact them into briquettes for incineration instead of animal feed. The only problem with that is the liquor that comes out of onion. So rather than giving it to animal feed we can use it somewhere else.*

A template approach was used in this discourse analysis involving key discourse categories developed from literature in light of data. This analysis of competing environmental discourses can be described as three interlinked analytical steps.

First, the Researcher revisited data collected in the Firm. This includes data from interviews and memory notes focusing on key participants and their motivations. The Researcher focused on who was involved, what they were trying to achieve, and what they did to achieve it. This means that the researcher went back into the raw data to identify what key participants said and did during identified events.

Second, discourse categories were developed from the literature and in light of data collected in the Firm. These discourse categories were then used to identify discourse orders. The latter refers to a set of interrelated story lines produced in practices and was found to shape practices in the Firm. For example, the idea that resource productivity is important was a typical story line in the Firm. However, different ways to achieve resource productivity was pursued.

Third, story lines produced by people in the Firm practices were mapped out along a time line. This analysis shows how environmental discourses compete and how certain discourses became dominant and shaped practices in the Firm. Table 3.5 show an example of a discourse order accounted for in this study.

Table 3-5: An example of a discourse order accounted for in this analysis

Logics	**Source of knowledge**	**Image of the natural environment**	**Image of the commercial context**	**Image of technology**	**Time horizon**
Techno-centric	Technology providers, consultants, regulators	Local surroundings such as local stream and local farm land	Harsh, competitive, short term	Engineering out problems; efficiency	Short term

This process of data analysis involved three analytical moves. Each move reflects on a more focused understanding of the environmental innovation journey. The following sections describe each analytical move.

3.3.2 The environmental innovation journey is a social process involving the construction of environmental problems and solutions

Following constructivist commentators in social sciences, it was found useful to explore how environmental innovation actually unfolds inside a firm situated in the UK food and farming sector. Ethnographic methods, e.g. participant observation and semi-structured interviews were developed to collect data, while literature on environmental innovation was explored simultaneously. Research objective 1 and 2 was identified to enable an understanding of environmental innovation and guide data collection in the Firm.

- **Research Objective 1:** To identify and critically reflect on environmental innovation in the UK food and farming sector

- **Research Objective 2:** To identify and critically reflect on theories of environmental innovation with specific reference to the environmental innovation journey conceptualised as a social process

Research objectives 1 and 2 were presented in chapter 2 and identified two gaps in knowledge. First, literature on environmental innovation in the UK food and farming sector with particular reference to food processing firms are limited. Second, the idea that environmental innovation is situated and unfolds through time and space has received growing interest in the sustainability debate. Insight from literature on environmental innovation rooted in the constructivist approach in social sciences identified the need to explore how an environmental innovation journey actually unfolds.

- **Research Objective 3:** To identify and critically reflect on the environmental innovation journey conceptualised as a social process involving the construction of environmental problems and solutions

Research objective 3 is met in chapter 5. Chapter 5 provides a reflective account of an environmental innovation journey involving the construction of environmental problems and solutions. The interpretive framework developed from literature to make sense of the environmental innovation journey seen in this way is provided in table 3-3.

Table 3-6: Interpretive framework developed to make sense of an environmental innovation journey involving the social construction of environmental problems and solutions (own development inspired by Beveridge and Guy, 2005; Hajer, 1999).

Analytical categories	**Description**
Situations	Consecutive time periods in which environmental innovation and the construction of environmental problems and solutions could be observed by the Researcher.
Environmental problem and solutions	Environmental problems are concerns about the Firm's relationship with the natural environment identified by various actors. Solutions are changes in the Firm posited and/or realised by various actors in response to identified environmental problems
Participants and their motivation	Main participants involved in the construction of environmental problems and solutions and motives articulated by these actors to pursue environmental innovations

In this perspective, the environmental innovation journey was conceptualised as a social process involving the construction of environmental problems and solutions. Findings in chapter 5 identified an account that accords with constructivist commentators in social sciences. The environmental innovation journey observed in this study was found to be messy in relation to realist accounts developed in literature to make sense of environmental innovation. However, this does not mean that making sense of an environmental innovation journey without making a mess of describing it is unachievable. Drawing on recent literature on practice theory of innovation social practices was identified as the unit of analysis.

3.3.3 The environmental innovation journey conceptualised as social practices

The environmental innovation journey observed in the Firm using ethnographic methods shows that people in the Firm do things in conjunction with technologies to produce performances. This insight accord with emerging literature focusing on practice theory of innovation and identified research objective 4:

- **Research Objective 4:** To identify and critically reflect on the environmental innovation journey conceptualised as social practices

Research objective 4 is met in chapter 6 and focus on an account of the environmental innovation journey conceptualised as social practices. An interpretive framework developed from literature rooted in practice theory identified an alternative way to account for (environmental) innovation. The interpretive framework developed to account for the environmental innovation journey as social practices is shown in table 3-4.

Table 3-7: Interpretive framework developed from literature to account for the environmental innovation journey conceptualised as social practices (own development inspired by Pantzar and Shove, 2010)

Elements of social practices	Description of elements
Participants	Participants are people that are found to be contributing to social practices in the Firm. A distinction is made between people that are seen as internal and external in relation to the Firm. People with employer contract with either the Firm or the Parent Group are treated as internal participants. People that affect social practices in the Firm without having an employer contract are treated as external participants
Images of performances	Images of performances are meanings and motivations embraced by participants about present and required performances to resolve environmental problems.
Technologies	Technologies comprise those things enrolled in practices by participants to complete performances. Technologies are divided into three categories: artefacts (e.g. food processing machines), devices (e.g. management frameworks) and infrastructures (e.g. buildings)

The environmental innovation journey conceptualised as social practices shows how new practices are developed, while existing practices are redeveloped and deleted over time. This insight stimulated further research to explore innovation in Firm practices: why new practices are developed and existing practices are redeveloped, while other practices are deleted. In accounting for innovation in situated practices, it was not seen useful to identify distinct factors such as drivers that cause practices to change, and barriers that resist change in practices. This is because reality is messy and complex, which make such causal relationship difficult to identify and isolate. This study rather found that practices were undertaken for a reason, which led to a third analytical perspective.

3.3.4 The environmental innovation journey conceptualised as social practices involving competing environmental discourses

The environmental innovation journey conceptualised as social practices shows how people in the Firm do things in conjunction with technologies to produce performances in relation to their imaginings of environmental problems and solutions required to resolve these. However, this practice view does not reveal why people in the Firm develop new practices and change existing ones, while deleting other practices. Drawing on literature that explores how competing environmental discourses shape social practices identified research objective 5:

- **Research Objective 5:** To identify and critically reflect on the environmental innovation journey conceptualised as social practices involving competing environmental discourses

Research objective 5 is met in chapter 7 and identified discourse analysis to account for competing environmental discourses in the Firm. The method developed to achieve this is presented in chapter 7. The interpretive framework identified to account for competing environmental discourses in the Firm was inspired by studies that focus on environmental discourses in other contexts. The interpretive framework developed in this study is shown in table 3-5.

Table 3-8: The interpretive framework developed in this study to account for the environmental innovation journey conceptualised as social practices involving competing environmental discourses (own development inspired by Farmer and Guy, 2001)

Discursive concepts	**Description**
Source of knowledge	How knowledge about environmental problems and solutions is constructed in social practices
Image of the natural environment	How the natural environment is conceived in social practices
Image of the commercial context	How social practices conceive success in the commercial context
Image of technologies	How technologies are conceived in relation to environmental problems and solutions
Time horizons	How time horizons are conceived in social practices

The environmental innovation journey conceptualised as social practices involving competing environmental discourses showing how social practices in the Firm are shaped by environmental discourses. The environmental discourses identified in this study were found to go beyond Firm practices, but were also found mobilised in social practices and therefore shaped by these to some extent. This study found a valid way to make sense of an environmental innovation journey conceptualised as social practices involving competing environmental discourses. This insight can usefully be transferred to study an environmental innovation journey in other contexts.

3.3.5 Time line of key features of the research process

This section provides a time line of key features of the research process. This time line identifies three phases. Each phase reflects on (1) key events observed in the Firm, (2) key participants accounted for in these events, and (3) method used to collect and analyse data. These phases reflect critical changes in the Firm stimulated further research.

Phase one represents the time period October 2008 to January 2010. This initial stage of this study identified a gap in knowledge and led to the open-ended question: How does the environmental innovation journey unfold in a firm from the UK food and farming sector? In consequence, a research perspective was adopted and flexible research design was used in the approach to this study. This means that data collection, analysis and literature review was undertaken simultaneously to explore the environmental innovation journey in the Firm.

A combination of Action Research (AR) and Ethnographic research methods were adopted to collect and analyse the data. AR was selected as the Firm was intending to develop and implement an environmental strategy. Key participants involved in this project were the Managing Director (MD1), the Group Advisor and the Factory Manager. The Researcher selected AR to facilitate development of this strategy together with these participants. At the same time, literature on environmental innovation theory in general and in the food and farming sectors in particular was identified. Ethnographic methods were also identified during this phase. It was found useful to reflect on events in light of relevant theories of environmental innovation identified in literature. A research diary was developed to capture events observed in the Firm. These events are described in greater detail in chapter 5. Table 3.6 show a summary of key features during this phase of the research process.

Table 3- 6: Key features of the research process in phase one

Time	Events	People	Method
October 2008 to January 2010	New waste removal performances; electricity project; water treatment plant project; development of factory management framework; water use project; marketing project; production throughput project	Managing Director (MD1); Group Advisor; Project Engineer Manager; Operational Director; Interim Operational Director; Factory Manager; Water Treatment Engineer; Marketing Consultant; Water Treatment Consultant	Combinations of Action Research and Ethnographic methods to collect and analyse data. An interpretive framework were developed and focused on situations, environmental problems and solutions, and participants and their motivations.

A distinction between phase one and phase two was made because of a particular event in the Firm. This event, described in chapter 5, involved changes in the people as well as the nature and direction of the environmental innovation journey. The role of the Researcher and the relationship with the Firm changed after this event. For example, the focus on the Environmental Strategy was abandoned. Participants in the Firm, e.g. MD1 and FM1 left the organisation. New participants engaged in the Firm such as the interim Managing Director (MD2) and Factory Manager 2.

Phase two reflects key features of the research process from February 2010 to October 2010. Methods used in this study also changed in phase two. Action Research was no longer considered appropriate for data collection. This is because Action Research requires other participants in the social setting to be engaged in the project, which they were not.

Instead of AR, ethnographic methods, participant observation and semi-structured interviews, became the principal mean for data collection. Moreover, a critical reflection of events occurring in the Firm and in light of theories of environmental innovation found in literature produced key insights. These initial insights from this study are presented in the end of chapter 5. In broad terms, these insights shows that environmental innovation in this Firm is more messy and complex than what realist 'clean' account suggest. This insight stimulated further research and identified theories of practice, which is detailed in chapter 6. A summary of phase two with reference to key features of the research process are provided in table 3.7.

Table 3- 6: Key features of the research process in phase two

Time	Events	People	Method
February 2010 To October 2010	Environmental Strategy was abandoned; A new operational management framework emerged; A NOBO board was developed; Environmental Officer was appointed; Environmental Reporting Framework developed; Environmental Management Framework	Interim Managing Director (MD2); Engineer Manager; Factory Manager 2; Water Treatment Engineer was appointed Environmental Officer;	Ethnographic methods such as participant observation and semi-structured interviews. Interpretive framework was refined so as to focus on social practices.

A distinction between phases two and three are made because of a further particular event in the Firm. This event is described in greater detail in chapter 5. Phase three accounts for the time beginning October 2010 to October 2011. This is because, firstly, that people in the Firm again changed, which also changed the nature and direction of the environmental innovation journey. Secondly, the role of the Researcher and his relationship with the Firm changed. People e.g. the interim MD 2 left the Firm and MD3 was appointed by the Parent Group. Moreover, the Parent Group appointed a Sustainability Director to take leadership in developing a Sustainability Strategy. Work on this strategy involved participants in the Firm including the Researcher. Following this event, the Researcher was spending less time in the Firm, while maintaining a relationship with key participants so as to collect data. Ethnographic methods were thus still used. However, rather than being positioned inside the Firm, the Researcher was now positioned outside the Firm looking in. Participant observation was used as method in meetings, and semi-structured interviews were conducted with key participants (e.g. Sustainability Director). Theories of practice and concepts of discourse analysis were considered during phase three to make sense of the environmental innovation journey. Table 3.8 shows a summary of key features of the research process during phase three.

6: Key features of the research process in phase 1

Time	Events	People	Method
November 2010 To October 2011	Sustainability Strategy developed at the Parent Group and The Firm	Sustainability Director; Manager; Factory Manager 2; Water Treatment Engineer/ Environmental Officer	The Researcher's position changed from insider, to outsider looking in. Ethnographic methods such as participant observation and semi-structured interviews. Interpretive framework was refined so as to focus on social practices and competing environmental discourses

This section has described the key features of the research process with particular reference to change in the events in the Firm, people participating in the environmental innovation journey and methods used to account for this process. The following section will provide a critical reflection on the research methods used in this study.

3.4 Research limitations

This study is rooted in a constructivist perspective in social science and is therefore limited to aid those interested in explanatory research. This study does not offer a tight prescription to understand how an environmental innovation journey develops in general. In contrast, environmental innovation journeys are context dependent and this study offers an approach to account for the context in which environmental innovation unfolds. The contribution of this study is not another theory of environmental innovation. This study rather developed a representation of an account of the environmental innovation journey, and can usefully aid others in this line of research (see conclusion and recommendation in section 8.3).

In accounting for the environmental innovation journey this study was undertaken in a firm from the UK food and farming sector. This research approach to data collection is limited for ethical and practical reasons. Each aspect of research limitations are discussed subsequently.

3.4.1 Practical limitations in research

Practical limitations refer to (1) time and (2) observations made by the researcher. First, data collection is limited to a particular context involving the Firm and the actual observations made by the researcher in relation to the Firm. This does not mean that the Firm's physical boundaries were the limit of this study, observations were rather limited to what went on inside the firm. Hence, those actors such as consultants, suppliers and customers that were found interacting with the Firm over time were accounted for. Second, time was limited as this study was undertaken during the course of this PhD. This means that the researcher was only able to account for what went on inside the Firm during this period of time.

Data collected in this study are limited to the researcher's observations. Data were collected based on actual observations and through semi-structured interviews. This approach to data collection involves danger of research biases, and respondent biases which can cause misleading interpretations for a number of reasons.

- First, data collected using participant observations was captured in a reflexive diary and reduced to memory notes. However, there is always a danger of memory being flawed and leading to misleading interpretation of data. The researcher addressed this problem by confirming findings around particular events with key individuals in the Firm.

- Second, data collected via semi-structured interviews can be flawed as the respondent may provide information on the basis of what he or she thinks the researcher would like to hear. The researcher addressed this problem by using mixed methods. Participant observations were used in this study to observe not only what people say, but also what people do. The researcher's relationship with the Firm as an insider provided the researcher with an opportunity to follow what was going on inside the Firm beyond face to face interviews, or as an outsider looking in.

- Third, data collection involving ethnographic methods such as participant observation and semi-structured interviews can be limited due to access to data. The relationship with the Firm enabled access to data. However, this does not mean that the Researcher had access to everything in the Firm.

- Fourth, data collection in this study was informed by literature and therefore selected on the basis of this. Following Law (2004) it is not possible to capture something in totality. There will always be something left out.

- Fifth, data analysis involved a process of developing a representation from data collected in the Firm with aid from literature. The researcher selected practice theory to organise data, and discourse analysis subsequently. However, this also means that data can be organised in a different way.

This study developed a representation of an account of the environmental innovation journey. This representation identified practices and environmental discourses, inspired by literature and selected by the Researcher, to make sense of the environmental innovation journey. However, this means that sense making involves decision about data collection and interpretations of data made by the researcher. In other words, something is accounted for and other things are not. For example, social practices and environmental discourses cannot be captured in their full complexity and do not have clear boundaries. Hence, this approach does not deny that reality is complex and messy, but that does not say we cannot try making sense of it. This study offers an approach to make sense of an environmental innovation journey. The next section considers ethnical implications of this research approach

3.4.2 Ethical implications of this research approach

Ethical implications of this research approach refer to (1) data collection and (2) developing a representation from the case study. This study involved people in a real life situation in the Firm. This produced ethical implications for data collection via ethnographic methods. Collecting data from participant observation and semi-structured interviews require informant consent. This was important so as to avoid any harm to participants in the Firm caused by the Researcher. This informant consent was developed prior to data collection and was shared with the other participants in the Firm. This consent form highlighted: (1) the role of the Researcher in the Firm, (2) key informants will be anonymised and (3) informants can withdraw from an interview if they wish to do so. This informant consent is detailed in Appendix D.

Ethical implications imposed challenges for disseminating the results from this case study. Representations from this case study included publication of research findings in conference papers, presentations at seminars and this PhD thesis. These representations were affected by a confidentiality agreement between the Firm and the University. In broad terms, this agreement aimed to keep the Firm and its participants anonymised. This agreement provided key participants in the Firm an opportunity to see the representation from this case study prior to publication. This means that a representation can change as necessary in light of this confidentiality agreement.

The challenge this imposed on this research was to provide sufficient insight on the environmental innovation journey without compromising this confidentiality agreement. This was addressed with careful considerations by the Researcher in collaboration with representatives from the University (e.g. supervisors) and representatives from the Firm. The researcher anonymised key participants accounted for in the Firm. However, these participants can be identified if the Firm is known. Hence, the Firm and anything that can identify the Firm in text was removed. Terminology used in the Firm was used in the representation from case study were possible. For example, managers in the Firm divided work in terms of operational and commercial practices. The terms operational and commercial were used in the Firm and in this thesis. However, key participants and aspects of the Firm that can identify the Firm were replaced with terms selected by the Researcher. For example, Managing Directors in the Firm were coded in terms of MD1, MD2 and MD3.

The representation from this case study is provided with sufficient detail so as to make valid and useful contribution to knowledge.

Having described the methods used in this study to collect and analyse data, how this was applied and research limitations, the following chapter will now provide details about the case study Firm.

4 The case study: a firm situated in the UK food and farming sector

This chapter provides details of the context of the phenomenon studied: an environmental innovation journey in a food processing firm situated in the UK food and farming sector. This study draws on a constructivist perspective in social sciences (cf. Beveridge and Guy, 2005; Guy and Shove, 2000) whose work identifies the need to understand the context in which environmental innovation actually unfolds. This chapter therefore introduces the research context with particular reference to the case study Firm and its specific sector, i.e. fresh produced ready meals. However, following Law (2004) the research context is not something that can be fully known. Hence, information about the case study Firm is selected by the Researcher and includes details about the research context. This chapter has the following structure:

4.1 Introduction	The introduction provides details about the sector in which the Firm is situated. This includes the ready meal market and position in the supply chain.
4.2 The Firm	This section provides details about the Firm's operations and organizational structure. Key operations are identified as procurement, production and sales. Organizational structure identifies roles and responsibilities organised around business functions
4.3 The environmental management context	The environmental management context identifies the key environmental impacts identified in this sector, environmental regulation and voluntary agreement. This section also identifies how the Firm organizes environmental management.
4.4 The Firm's Environmental Strategy	This section provides detail about the Environmental Strategy. This strategy formed the basis of this PhD and was developed prior to data collection for this thesis.

4.1 Introduction: the Firm and the ready meal sector

The following section introduces the Firm and the fresh-produce sector that produces and supply ready meals. A fresh-produced ready meal, illustrated in Figure 4.1, is a pre-made meal found in the food retail sector. A typical ready-meal is offered as a 'ready-to-eat' meal and requires therefore less work-input, e.g. cooking, by the end consumer. The Firm is specialised in sourcing a large variety of vegetables from farmers, e.g. potatoes, carrots and onions, and supplies these to ready meal manufacturers. The Firm runs a factory in which fresh vegetables are cleaned, peeled, diced, packed and distributed to customers, which are the ready meal manufacturers.

Figure 4-1: A typical ready meal

A key characteristic of this sector that produces and supplies ready meals is that the vegetables are fresh and remain fresh from farming to the end-product. This means that vegetables are not heated or frozen to extend their shelf life. The time it takes for the vegetables to 'travel' from the primary producer, which is farming, to reach the end-consumer via UK food retailers is therefore an important factor in this context.

The production and supply of vegetables from farming through to consumers of ready meals involves many stages, which can be described as a commodity chain. The commodity chain from the Firm's point of view is illustrated in Figure 4.2 and includes the following key stages: farming, food processing, ready meal manufacturing and retail.

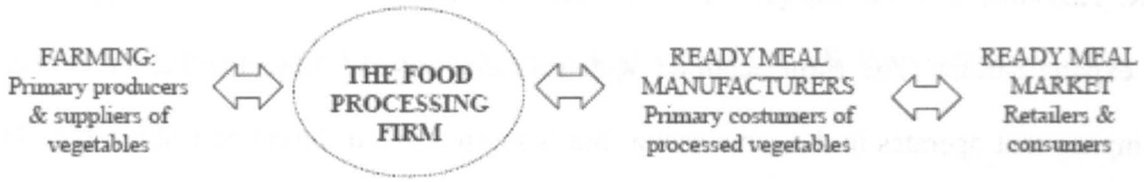

Figure 4-2: the position of the food processing Firm in the commodity chain of ready meals (own development based on insight from the Firm)

The commodity chain provides a broad overview of the Firm's context and the main operations involved in the production and supply of ready meals. The Firm buys a variety of vegetables, e.g. potato, carrot, and onions, produced by farmers located both in the UK and overseas. The vegetables arrive fresh from the field and are transported in lorries to the Firm's factory. The food processing activities in the Firm's factory involve (1) cleaning the raw vegetables, (2) peeling, dicing and packaging into a variety of products, and (3) distribution of finished products to ready meal manufacturers. The ready meals are sold to end-consumers by UK food retailers.

This study focused on an account of an environmental innovation journey explored in the Firm situated in this food and farming context described above. The subsequent sections will provide details about the Firm, its operations and the environmental management context. The information about the case study context is based on data collected by the researcher using ethnographic methods, e.g. participant observation and semi-structured interviews.

4.2 The UK food processing Firm

The UK food processing Firm originated as a farm business located in a rural area and developed over time into an expanding commercial industry. The farm business sold the Firm to a UK food group (the Parent Group), which includes several food companies in the UK. This shift in ownership provided the Firm with financial security and an opportunity to expand further. The Firm acquired with financial support from the Parent Group a company that operates in the same sector, but is located in a different part of the UK. The Firm therefore exists on two sites: the Firm and the Northern Acquisition. This way it was made possible for the Firm to supply its products to a larger part of the UK market.

This study was undertaken at the Firm. The Firm has 275 employees and an annual turnover of £25m (in 2008). The Firm is seen by its customers as a well known and trustworthy brand in the UK fresh-produced sector. This image is achieved because of the time the Firm has operated in this sector. The Firm's competitive advantage was identified by the Researcher to include a combination of the following factors: (1) product price, (2) customer service, and (3) product quality.

The price of the Firm's products supplied to ready meal manufacturers was found to be an important factor because of the competition from other companies in this sector. The cost of the Firms operation includes three factors in particular; these are (1) the cost of raw materials, (2) labour, and (3) transport. A critical focus in the Firm was therefore to ensure that the costs of producing the finished products did not exceed the price paid by the customers, i.e. ready meal manufacturers. However, product price was found to be affected by the Firm's customer service identified as a second competitive advantage.

The Firm has developed a unique customer oriented production line in a factory that can offer a wide range of fresh vegetables in different varieties and cut sizes. For example, different types of potatoes are offered to customers in different cut sizes such as 10 or 15 millimetre cubes. This competitive advantage of product variety is realised from well established sourcing arrangements of vegetables. The procurement of vegetables is achieved through relationships with farms located both in the UK and overseas.

A third factor found to be important in the Firm is product quality, which involves particular reference to food safety and production requirements. It is very difficult to a company in general to operate in the UK food and farming sector without appropriate arrangement that ensures that the food products that are supplied to consumers are safe to eat. The focus on product quality in the Firm can be divided in two areas identified by the Researcher; these are: (1) food safety as required by food regulation and (2) specific requirements identified by the Firm's customers.

Product quality with reference to food safety is achieved in the Firm following the guidelines developed by the UK Food Standards Agency. These guidelines includes descriptions how to handle, prepare and store food as to prevent food-borne illness. The recommendations are published in the Hazard Analysis and Critical Control Points programme and are certified by a third party monitor (e.g. EFSIS[9] grade A). This certification is re-established in the Firm through annual audits of the production process. It was found very important and valuable to the Firm to maintain the highest level of food safety standard to be able to supply the ready meal market.

Product quality also includes specific requirements identified by the Firm's customers (e.g. ready meal manufacturers) and UK food retailer requirements that are passed onto the Firm. These quality requirements involves, among other things, vegetable's country of origin, vegetable variety (e.g. specific kinds of potato), what chemical-inputs (e.g. pesticides) are used the farmers that supply to the Firm. These quality aspects are detailed in retailer-led programmes (e.g. Assured Produced[10], LEAF[11], and Field to Fork[12]). The Firm has developed a competent production arrangement to achieve quality accreditation pursued by both customers and third party monitors focusing on quality in terms of food safety, health and hygiene.

This section has described the Firm and identified three factors found by the Researcher to be important to the Firm's operations; these are: product price, customer service and product quality. The following section provides details about the Firm's operations and its organizational context.

[9] EFSIS: European Food Safety Inspection Service (www.ukagriculture.com)
[10] Assured Produced: is a scheme for members of the food industry that provides retailers and consumers with confidence about product qualities in terms of food safety and environmental protection; Red Tractor Farm Assurance Fresh Produce Scheme (former AP). Available at: http://assurance.redtractor.org.uk/rtassurance/farm/produce/pr_about.eb
[11] LEAF stands for Linking Environment and Farming. This organization is a charity that promotes environmentally responsible farming (www.leafuk.org)
[12] Mark & Spencer Field to Fork:

4.2.1 The Firm's operations and organizational structure

The following section describes the operations developed in the Firm to supply pre-cut vegetables to ready meal manufacturers. The operations developed in the Firm were found by the Researcher to be organized around three areas; these are (1) procurement of vegetables from the primary producers, which are farms, (2) food processing in the factory, which includes cleaning, peeling, dicing and packaging, and (3) delivering finished products to customers, which are the ready meal manufacturers. The Firm is organised into a number of units developed to achieve its operations; these unit are: commercial, technical, production and finance. An overview of the Firm's organizational structure is provided in Figure 4.3.

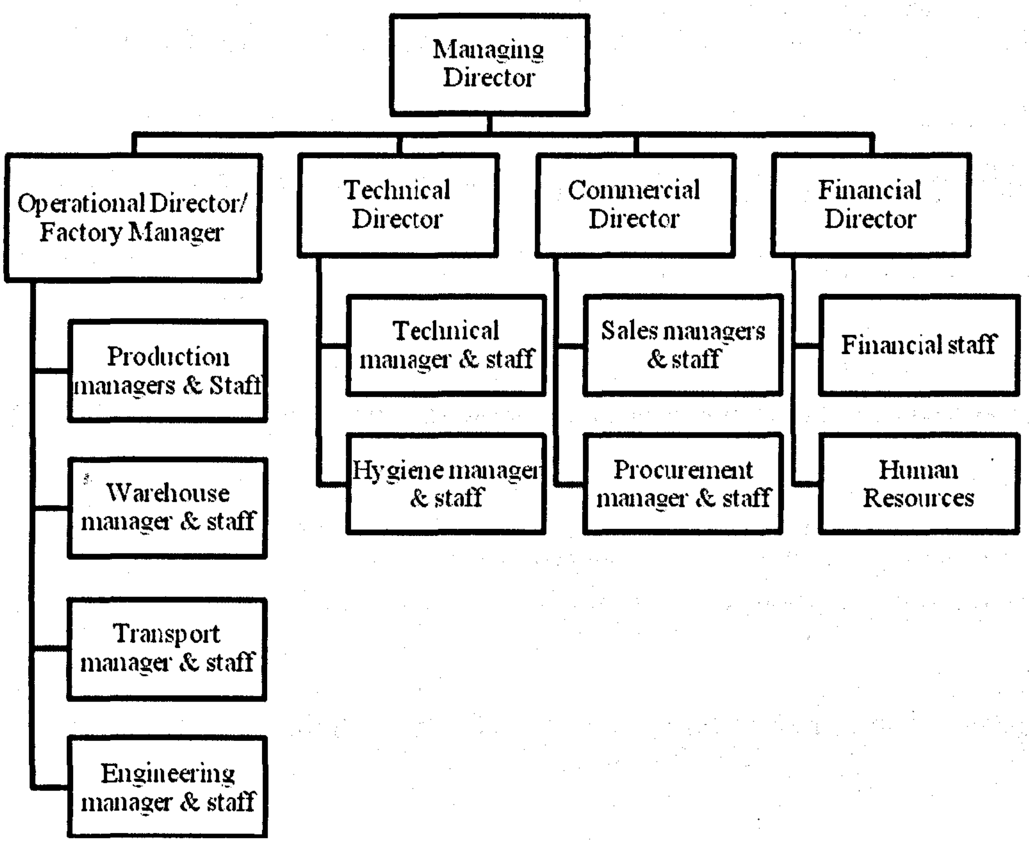

Figure 4-3: The Firm's organizational structure (Adopted from the Firm)

The Firm's organizational structure includes a Managing Director who oversees the Firm's operations. There are several directors with responsibility for specific operations; these are:

operational director or factory manager, technical director, commercial director and financial director. The commercial director oversees the procurement and sales of finished products. The operational director/factory manager oversees the operations in production. The technical director is responsible for the operations involving product quality from the supplier through to the customer. The financial director oversees the financial situation with particular focus on the costs of running the operations including the human resources required. Having introduced the Firm's organizational structure, the Firm's operations are discussed subsequently.

4.2.1.1 Procurement of vegetables

The Firm has well established sourcing arrangements of vegetables from farmers located both in the UK and overseas as shown in Figure 4.4. The variety of vegetables sourced by the Firm can be divided into two product groups; these are (1) potato, carrots and onions, which accounts for a large portion of the volume produced in the Firm, and (2) 'exotic' vegetables, which include those vegetables produced in smaller, but substantial, volumes such as pepper, garlic, lemongrass, mooli, butter squash, mushrooms, green beans, chillies, courgette, spring onions, tomatoes, swede and cauliflower.

Figure 4-4: A world-map showing a flavour of countries from which the Firm source raw materials (own development based on insight from the Firm)

The Firm seeks to supply vegetables from farmers in the UK when this is possible. However, customers (i.e. ready meal manufacturers and UK food retailers) demand vegetable products that are not produced in the UK all year around. The Firm has therefore established procurement relationships in many countries. The diagram in Figure 4.4 shows a map of some of the countries the Firm sources vegetables. The Firm's choice of vegetable suppliers is affected by, among other things, customer demand, food industry certificate programmes and seasonality.

In broad terms, customers (i.e. ready meals manufacturers) demand a variety of fresh vegetables all year around, which explains the Firm's sourcing arrangements described above. A key element that affects these sourcing arrangements is the food industry certificate programmes described in section 4.2. The Firm cannot supply vegetables to the ready meal market if their suppliers, i.e. farmers, are not certified as requested by ready meal manufacturers and UK food retailers. Procurement actors in the Firm must therefore make sure that suppliers conform to relevant accreditations. This section has described the Firm's procurement operations; the following section describes the production in the factory.

4.2.1.2 Production in the factory

The production in the factory includes a number of activities from vegetable intake and storage through to cleaning, peeling, dicing and packaging. The vegetables arrive at the Firm's factory in lorries. The intake of vegetables includes quality controls to make sure the appropriate requirements are met. The vegetables are then stored in different types of warehouses depending on the temperature appropriate to the specific vegetable. Storage temperature is important as to ensure product quality.

The production of pre-cut vegetables takes place in the factory. The factory includes a flexible production line with different food processing machines to enable processing of a large variety of vegetables. A key factor that affects production is to ensure that vegetables remain fresh. The production in the Firm is therefore organised to respond to customer demand at short notice. The production of the majority of products includes the following steps (1) peeling, (2) dicing, and (3) packaging. The production in the factory gives rise to a number of waste streams. An overview of the factory and key operations in relation to production is provided in Figure 4.5 and described subsequently.

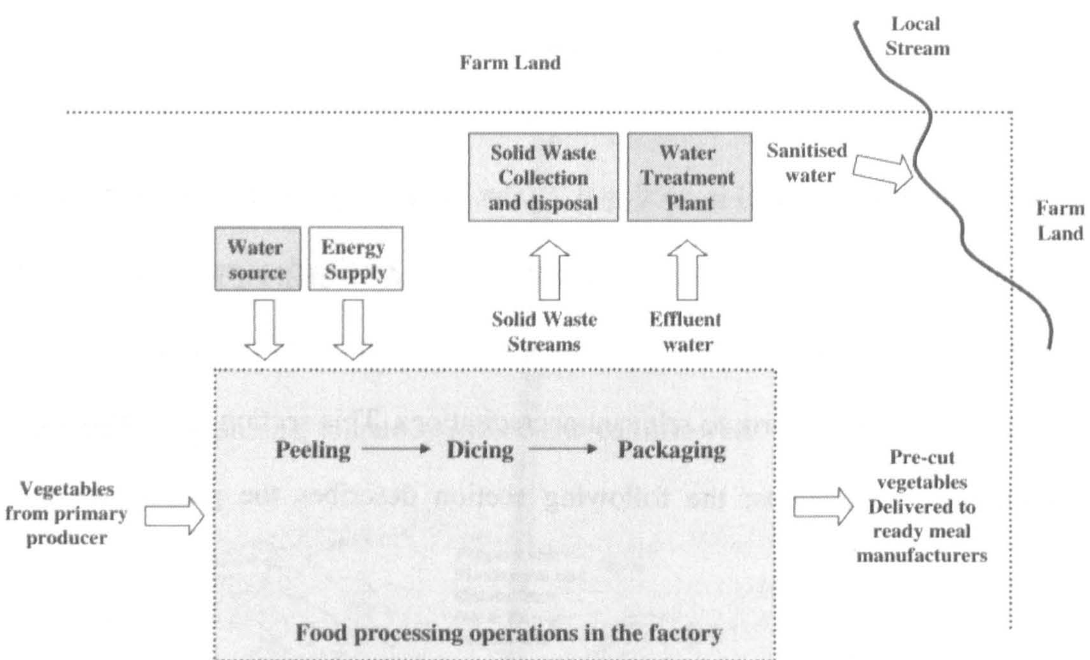

Figure 4-5: Location of the Firm and main operations around the factory (own development)

First, vegetables arrive from farms and are contaminated with soil. Water is therefore used in the factory to clean the vegetables and protect these from further contamination throughout the production process. The Firm sources its water from its own borehole located near the factory.

Second, a large proportion of the vegetables, such as potatoes, carrots and onions, has skin and is therefore peeled prior to further operations. Peeling takes place in machines designed to remove the skin and clean the vegetables simultaneously. Third, the vegetables are then diced in machines into different cut sizes. Fourth, the diced vegetables are packed in plastic bags, which are stored in a cooled despatch central prior to delivery to ready meal manufacturers.

The operations in the Factory give rise to waste streams. These include (1) water effluents, which is contaminated with organic waste particles from production (2) organic dry waste, e.g. onion skin, and (3) solid waste streams, e.g. plastic and cardboard materials. The solid waste is removed from the factory into waste-skips for recycling. The organic dry waste is removed to trailers and delivered to local farmers for animal feed. The water effluents is sanitised in the Firm's own water treatment plant. The water treatment process includes different stages through which the organic waste particles are separated from the effluent water. The outcome from the water treatment process is (1) sanitised water, and (2) organic sludge. The sanitised water is discharged to a local stream near the factory. The organic sludge is used as fertiliser by local farmers.

4.2.1.3 Delivery of finished products to ready meal manufacturers

The finished products are supplied to ready meal manufacturers. The Firm's sales department is responsible for taking customer orders and making sure that products are delivered to the customers. The sales department therefore involves a transport department to deliver finished products direct to customers. The Firm, including the Northern Acquisition, have developed a UK wide distribution network and delivers fresh pre-cut vegetables to ready meal manufactures via their own transport fleet. The sale of finished products is affected by, among other things, product price, customer service, and product quality as described in section 4.2.

Having now described the Firm's operations and organizational structure, the following section provides details about the Firm's environmental management context.

4.3 The environmental management context

The following section provides details about the environmental management context with reference to environmental impacts and relevant environmental regulations found in the Firm. The environmental impacts identified in the UK food and farming sector with particular reference to actors beyond the farm gate such as food processing firms includes (1) water use, (2) energy consumption, (3) transport, and (4) water effluents and solid waste streams.

4.3.1 Environmental impacts

Water is used in food processing operations to clean vegetables and protect these from further contamination and deterioration throughout the production process. Water is also used for cleaning the factory including food processing machines to meet hygienic requirements. Energy consumption in food processing operations includes refrigeration to keep vegetables at appropriate temperatures throughout the production throughput. Additional energy consuming activities specific to the Firm includes compressors used for running food processing machines and supplying oxygen to the water treatment plant.

A DEFRA[13] report published 2006 identifies transport as a key environmental impact in the UK food and farming sector as a whole accounting for 25% of UK Large Goods Vehicles (HGV) kilometre. Lorries are used for transport of vegetable products across the commodity chain from farms to food processing through to ready meal manufacturers and food retailers. The Firm owns and runs a lorry fleet to deliver finished products to their customers.

Food processing operations give rise to water effluent and solid waste streams. The solid waste stream such as onion skins is used by local farmers as animal feed. The effluent water used in the Firm is contaminated with rest products from production and is sanitised in a water treatment plant. The output from the water treatment process is sanitised water and organic sludge. The sludge is used by local farms as fertilizer. The sanitised water is discharged into a local stream.

4.3.2 Environmental regulation and voluntary agreement

The following section describes the main environmental regulations and voluntary agreements affecting the Firm. The regulated schemes relate to the environmental impacts described above with reference to water use, energy consumption, water effluent, solid waste streams and transport.

The Firm abstracts water from its own borehole, which is regulated by the Environment Agency (EA) and includes a water abstraction licence. The water abstraction licence includes details of the amount of water the Firm can abstract annually. The water abstraction license is renewed with the EA every 10 years. The Firm owns and runs a water

[13] DEFRA report: see footnote 2

treatment plant to sanitise the water after it is used in the factory. The Firm therefore has a water discharge license regulated by the EA. The water discharge license includes details about the quality requirements needed to discharge the sanitised water into the local stream.

Energy consumption in the Firm is affected by the Climate Change Levy, which is a tax on energy used by UK industries. The intended aim of this regulation scheme is to provide an incentive for companies to pursue energy efficiency so as to reduce carbon emissions. In response to this governmental scheme the Firm is required to collect information about energy efficiency. This information includes annual electricity consumption compared to the annual quantity of finished products produced in the factory. Information about energy efficiency identified in the Firm is supplied to UK authorities on annual basis.

Solid waste streams are regulated so as to stimulate the recycling of waste materials such as plastics and cardboard. A key regulation that affects solid waste streams in Firm is therefore the landfill tax. The Firm's water treatment process gives rise to organic sludge, which is used by local farms as fertilizer. The sludge is spread on land and the Firm needs a specific permission for this, which is regulated by the EA.

Transport is affected by specific regulations concerning the use of HGV vehicles.

The Firm is committed to the Food and Drink Federation voluntary agreement scheme, which works in parallel to environmental regulation schemes. The FDF voluntary scheme includes information and advice on best environmental practices developed through collaboration between industrial and UK government programmes to suit specific challenges. For instance, guidelines for 'energy best practice' have been developed by the Carbon Trust[14], including methods for carbon foot printing and ways to manage the Carbon Reduction Commitment; guidelines for waste and water efficiency have been developed by Envirowise[15]; and guidelines for resource efficiency by WRAP: Waste Resources Action Programme[16].

A key difference is that regulated schemes are compulsory, while the voluntary scheme is optional. The voluntary agreement focusing on environmental management in the UK food industry is established by the FDF. This organisation includes food manufacturers, food trade associations and other groups specialised in food sectors. The FDF represents the UK food industry and provides a link between the food industry and government, regulators, consumers and the media. The work by FDF is organised in three areas: food safety and science, health and well being, and sustainability and competitiveness. The work on sustainability is organised around the voluntary agreement developed by FDF and focuses on specific environmental themes. The environmental themes relevant to the Firm are the following:

- Achieve a 35% absolute reduction in CO_2 emissions by 2020 against a 1990 baseline;
- Seek to send zero food and packaging waste to landfill at the latest by 2015 and make a significant contribution to WRAP's Courtauld 2 target of reducing product and

[14] Carbon Trust: Organization that give advice for low carbon economy. Report published to promote methods for energy best practice in food sectors. Accessed online 2010-06-01. Available at: http://www.carbontrust.co.uk/cut-carbon-reduce-costs/products-services/sector-advice/Pages/food-drink-tobacco-2.aspx

[15] Envirowise: Envirowise, 2010. Waste and water efficiency in food sectors. Accessed online 2010-06-01. Available at: http://www.envirowise.gov.uk/uk/Sectors/Food-and-drink.html

[16] WRAP (Waste Resource Action Program). 2010. Food waste and resource efficiency. Accessed online 2010-06-01. Available at: http://www.wrap.org.uk/retail/supply_chain/index.html

packaging waste in the supply chain by 5% by the end of 2012 against a 2009 baseline;

- Achieve significant reductions in water use to help reduce stress on the nation's water supplies and contribute to an industry-wide absolute target to reduce water use by 20% by 2020 compared to 2007;
- Embed environmental standards in transport practices, including contracts with hauliers as they fall for renewal, to achieve fewer and friendlier food transport miles and make a contribution to IGD's Efficient Consumer Response UK Sustainable Distribution Initiative to save 200 million HGV miles over the period 2007-12 in the grocery sector.

The environmental themes identified by FDF include specific targets developed for the overall industry and not for individual firms. For example, a food industry wide commitment is to achieve a 20% reduction in absolute water use by 2020 compared to 2007). The FDF have established relationships with other organizations (e.g. the Federation House commitment and Carbon Trust) to provide firms in the food industry sector with knowledge and expertise to achieve improved environmental performances (e.g. water use). The performance indicators are identified in light of each environmental theme. An overview of the FDF voluntary agreement, its targets, programmes and performance indicators is detailed in table 4.1.

Table 4-1: The FDF voluntary agreement: environmental themes, target, programmes and identified performance indicators (adopted from FDF, 2010)

Environmental Themes	FDF Targets	Programmes	Performance Indicators
Water	Reduce water use by 20% by 2020 compared to 2007.	Federation House Commitment; Envirowise	m^3/tonnes FP Total m^3
Energy	Achieve a 20% absolute reduction in CO2 emissions by 2010 compared to 1990	Carbon trust,	kWh/Tonnes FP; %Renewable Energy
Food Transport	Reduce its environmental and social impacts by 20% by 2012 compared to 2002	Fewer Friendlier Miles Programme	%Vehicle fill, miles/Tonnes FP
Landfill	Zero food and packaging waste to landfill from 2015.	Waste Resource Action Programme (WRAP)	% of Annual Reduction

The Firm's commitment to the voluntary agreement was established via the Parent Group. The Firm is not committed as an individual organization, but as a member of the Parent Group, which involves other firms. The Parent Group have therefore organised an environmental committee to meet the requirements established by FDF. The environmental committee is organised around quarterly meetings and includes individual participants from each firm. The environmental committee also addresses environmental regulations.

The Managing Director (MD1) appointed by the Parent Group to take leadership in the Firm had a particular interest in the environment. The Firm's strategy identified by MD1 included a particular focus on the environmental. The following section provides details about the Firm's Environmental Strategy.

4.4 The Firm's Environmental Strategy

The Firm's Environmental Strategy was identified by MD1. Work to develop this Environmental Strategy was initiated by MD1 who engaged both the Researcher and Supervisor 1 in this task via an MSc thesis (Langendahl, 2008). A relationship was established with the Firm through this earlier research, which led to a further project being commissioned to help further develop the Environmental Strategy and assist in its implementation. The research conducted forms the basis of this thesis.

The stated aim of the Environmental strategy was to enhance the Firm's competitive advantage by improving environmental performances (e.g. water use, energy consumption and solid waste generation) in light of the Firm's operations (procurement, production and transport). The rationale at work here was resource management with particular focus on win-win solutions. The concept of win-win was not explicitly used in the Firm (it was not part of their glossary), but the essence of what key participants (e.g. MD1) said and did in the Firm has reference to this concept. Drawing on the work of Ekins (2005), win-win can be described as improvements in environmental performance which at the same time reduced the cost of factor inputs. The Environmental Strategy therefore involved a particular focus on (1) water use, (2) energy consumption, (3) transport and (4) production throughput. An overview of this Environmental Strategy is provided subsequently.

4.4.1 Production throughput

The production throughput concerns the operations involved in production and supply of pre-cut vegetables. The cost of vegetable inputs accounts for a large portion of the overall cost in production. The production throughput is therefore a cornerstone of the Firm's Environmental Strategy and identified as the ability to effectively and efficiently produce pre-cut vegetables. The Firm's strategy identified to achieve this included (1) developing sourcing arrangements of vegetables that are suitable for the food processing machines (e.g. size and texture), and (2) developing the production operations as to make the most out of each product line and thereby minimise the waste streams (e.g. solid organic waste).

Sourcing appropriate raw materials formed part of the Firm's procurement strategy. This involved a particular focus on the selection of growers with the ability to supply raw materials with particular qualities (e.g. size). This was important because if raw materials are undersized they can fall through the production process and end up as waste. To ensure appropriate supply of raw materials, MD1 suggested a procurement strategy involving two measures in particular: (1) building closer relationship with growers, and (2) working with growers as strategic partners on long term contracts.

Procurement was at this time involving a number of intermediate actors placed between the Firm and its suppliers. Thus, building closer relationship with growers could reduce the extra cost of sourcing raw materials via intermediaries. The rationale, according to MD1, of working with the growers in the longer term (as strategic partners) involved the potential of influencing the growers and what raw materials they grow. MD1 captured this ideas as an image of 'round potatoes': If the Firm could source round potatoes with a particular size they would be able to use these more effectively in production.

Developments in the factory operations focused on making the most out of the vegetable inputs to achieve a higher level of product output and thereby reduce the cost of production. Lean manufacturing was identified to improve production throughput. Lean manufacturing is a management philosophy that seeks to eliminate wasteful use of resources (e.g. raw materials), which can reduce the cost of factor inputs in production. Work to realise lean manufacturing was led by the Operational Director and involved a project which stretched over a long period of time. A key development identified in this project was a Framework to measure and monitor vegetable inputs and outputs in the production process. This aimed to provide production with key performance indicators: information about production efficiency with respect to all finished product.

4.4.2 Energy consumption, water use and transport

The Firm's environmental strategy identified a need to address energy consumption, water use and transport in the Firm's operations. The underlying rationale was to reduce cost. For example, by reducing energy consumption the Firm's operation will make savings on the electricity bill. For example, compressors used in production to operate food processing machines were identified as a key aspect associated with electricity use. It was noted that work carried out prior to this PhD project identified it useful to replace existing compressors with more efficient ones. New compressors make more efficient use of electricity and therefore reduce cost of energy consumption.

Moreover, the Firm's Environmental Strategy identified by MD1 also involved an interest to invest in renewable energy technologies such as wind-turbines. An investment in wind-turbines would not only provide the Firm with electricity, but can also have symbolic value aimed to enhance the Firm's 'green' image.

This Environmental Strategy developed in the Firm formed the basis of this thesis research, which included the Researcher as participant.

4.4.3 The Researcher

The Researcher was invited to participate in the work to assist further development and implementation. The Researcher engaged with the Firm in October 2008 and visited the Firm in consecutive time periods until October 2011. This relationship with the Firm provided the Researcher with an opportunity to explore how environmental innovation actually unfolds in the Firm. The observations made by the Researcher are presented in chapter 5, which is a chronological narrative.

The chronological narrative includes many human actors and technologies that are specific to the Firm including organizations which the Firm has relationships with. Appendix C presents a description of these human actors, technologies and organizations involved, together with a definition of any acronyms used.

4.5 Summary

This summary draw on the key findings from exploring the research context: the Firm situated in the UK food and farming industry and operates in the fresh-produce sector. These findings identify the main characteristics of this commercial context and provide useful information for subsequent chapters. The main characteristics are:

Space – the Firm operates in the fresh produce sector and supply pre-cut vegetables to ready meal manufacturers. The geographical location of the Firm is the factory and offices situated in the UK. However, the vegetables are sourced from many different countries depending on different growing seasons. In this way, the Firm is linked to farmers in many parts of the world. The Firm's products are distributed to ready meal manufacturers, who provide food retailers with ready meal commodities. In this way, the Firm is linked with the UK food retail sector and consumers of ready meals.

Time – the fresh produce sector consists of food commodities, i.e. vegetables, that are fresh from the fields and have to remain fresh through to the end consumer. Time is therefore a major concern in the Firms operations.

Quality – food commodities are produced for consumption. Food quality is therefore a key priority in the Firm. Well established procedures are developed in the Firm for this reason, which are affected by specific food regulations found in this sector.

Environmental impacts and management – the main environmental impacts found in this part of the sector are: energy consumption, water use, solid waste streams and transport. These environmental impacts are reflected in the operations associated with the Firm. Environmental management in the Firm was found concentrated on (1) resource management and (2) compliance with environmental regulation. Resource management concerns the cost of factor inputs such as water, energy and vegetables and seeks ways to improve resource productivity. Improvement in resource productivity can be described as an increase in the level of output of finished products while reducing the level of inputs. Compliance with environmental regulation was found concentrated on energy consumption, water use, solid waste streams and effluent water.

Having described the key findings from the research context, the following chapter explores the environmental innovation journey.

5 Exploring the environmental innovation journey: how environmental problems and solutions are socially constructed over time

This chapter is the first out of three results chapters. The second and third results chapter is found in chapters 6 and 7. This chapter presents a reflective account from exploring the environmental innovation journey in the Firm situated in the UK food and farming sector. Information about the research context and the Firm is provided in chapter 4. The purpose of this chapter is to provide the details of environmental innovation *process* accounted for in the Firm. Method to explore the environmental innovation journey involved an ethnographic approach, e.g. participant observation and semi-structured interviews, described in chapter 3. The structure and content of this chapter is described below.

5.1	**Introduction**	The introduction draws on the research perspective developed in chapter 2 and revisits research objective 3. The interpretive framework developed from literature to account for the environmental innovation journey as a social process involving the construction of environmental problems and solutions is described
5.2	**Exploring the environmental innovation journey**	The findings from exploring the environmental innovation journey, conceptualised as a social process involving the construction of environmental problems and solutions, is presented in a temporally ordered narrative. The narrative is organised around consecutive time periods at which the construction of environmental problems and solutions were observed in the Firm. A summary of environmental problems and solutions constructed in the Firm is provided at the end of this narrative.
5.3	**Summary and Critical reflection**	A summary of the findings from exploring the environmental innovation journey, conceptualised as a social process, identifies the key characteristics of this process. Environmental innovation is a non linear process involving temporal achievements that are reversible. This critical reflection shows that the constructivist

critique of realist accounts to make sense of an environmental innovation journey, described in chapter 2, is valid. This insight stimulated further research to explore a different perspective to make sense of an environmental innovation journey. This perspective draws on practices theory of innovation and identifies social practices as the unit of analysis.

5.1 Introduction

The idea that environmental innovation is situated and unfolds through time and space inspired this study to explore an environmental innovation journey (cf. chapter 2.4.1). A relationship with a food processing firm situated in the UK food and farming sector provided an opportunity for this research. Following constructivist commentators in social sciences, e.g. Guy and Shove (2000) and Beveridge and Guy, (2005), a research perspective, and not a theory, was developed in the approach to this study (cf. chapter 2.4.5).

This study follows Beveridge and Guy (2005) and more recently Oak (2010) and conceptualises the environmental innovation journey as a social process. In this social process, the environmental innovation journey involves the interaction and negotiations between participants seeking to resolve environmental problems. Using such an approach is reflected in this study's third research objective:

- **Research objective 3**: To identify and critically reflect on the environmental innovation journey conceptualised as a social process involving the construction of environmental problems and solutions.

Research objective 3 provided the starting point of this study and therefore the beginning of the funnel described in section 1.3.3. An interpretive framework was developed to meet research objective 3. This interpretive framework developed from literature on environmental innovation and is rooted in a constructivist perspective in social sciences. Details about this interpretive framework are provided in the following section

5.1.1 Interpretive framework

This framework, shown in table 5.1, was developed using a template approach to data analysis described in section 3.1.4. The framework consists of analytical categories identified in literature on environmental innovation. Following constructivist commentators in social sciences (cf. Beveridge and Guy, 2005; Guy and Moore, 2005; and Hajer, 1995), the analytical categories identified to account for an environmental innovation journey are:

- the situations with reference to time and space;
- the social construction of environmental problems, which is viewed as concerns about environmental impacts articulated by participants, which are the human actors involved in the environmental innovation journey;
- the solutions to the environmental problems posited by the participants, and
- the main participants involved and their motivations.

Although this interpretive framework was developed to make sense of the environmental innovation journey, to some extent, the purpose of this chapter is to provide a rich and detailed account of environmental innovation *process* observed in the Firm (Geertz, 1973). The rationale for this approach follows Law (2004) who argues that reality is much more complex and messy than realist accounts suggest. This chapter therefore reflects on the 'mess' and make sense of it in subsequent chapters (cf. chapter 6 and 7). This interpretive framework developed to account for the *process* of an environmental innovation journey is detailed in table 5.1.

Table 5-1: Interpretive framework to account for the environmental innovation journey conceptualised as a social process (own development inspired by Beveridge and Guy, 2005 and Hajer 1995)

Analytical categories	**Description**
Situations	Consecutive time periods in which environmental innovation and the construction of environmental problems and solutions could be observed by the Researcher. The Researcher engaged with Firm as participant observer from October 2008 to October 2010, and as an outside looking in from November 2010 to October 2011.
Environmental problem and solutions	Concerns about the Firm's relationship with the natural environment that are selected by various actors and changes in the Firm posited by various actors to resolve environmental problems
Participants and their motivation	Main participants involved in the construction of environmental problems and solutions and motives articulated by actors to pursue environmental innovations

The constructivist research perspective described in chapter 2 provided the starting point for exploring the environmental innovation journey in the Firm. The interpretive framework, shown in table 5.1, developed in this study and was applied to account for the environmental innovation journey as a social process involving the construction of environmental problems and solutions.

This interpretive framework therefore includes reference to the situations in which environmental problems and solutions are socially constructed. This perspective identified the participants involved and their motivations as the prime movers in this process. Research findings from exploring the environmental innovation journey conceptualised as a social process are presented in a temporally ordered narrative below. A summary and critical reflection is provided at the end of this chapter.

5.2 Exploring the environmental innovation journey: how environmental problems and solutions are socially constructed over time

This section presents a temporally ordered narrative and reports data collected in the firm during consecutive time periods. The interpretive framework described above was applied to achieve this. This narrative reflects on those situations in which the environmental innovation journey involving the construction of environmental problems[17] and solutions could be observed by the Researcher.

The position of the Researcher inside the Firm made it possible to observe environmental problems and solutions as they actually happened in the Firm. The Researcher therefore accounted for himself as a participant of the environmental innovation journey. However, the Researcher was, for practical reasons, not able to be 'everywhere' or 'all the time' in the Firm. Hence, the situations reported in this narrative are derived from actual observations using ethnographic methods such as participant observations and semi-structured interviews described in chapter 3.

[17] Environmental problem: the term environmental problem refers to the sociological concept of environmental innovation and means that environmental problems are made in a social process. Environmental problems are in an environmental management context labelled as environmental aspects and impacts.

In this study, observations are not limited to the Firm's physical/organisational boundaries and participants (e.g. managers) within the Firm. The Firm is rather viewed as a site in which the environmental innovation journey unfolds. The nature and direction of the environmental innovation journey was found to be affected by human participants inside the Firm but also by actors that are external to firm such as customers and consultants. The Researcher therefore accounted for those participants interacting with Firm. Moreover, technologies such as food processing machines and the water treatment plant were found to affect the social construction of environmental problems and solutions and are therefore included in this reflective narrative. Details about participants, technologies and organisations accounted for in this reflective narrative is provided in Appendix C

The Researcher engaged with the Firm in October 2008 to participate in work to realise the Firm's environmental strategy described in chapter 4. The underlying rationale of this strategy was found to involve an emphasis on resource management. This rationale includes a particular focus in the Firm to identify and realise measures to achieve 'win-win' solutions that improved environmental performances, e.g. energy consumption, while at the same time reduced the cost of factor inputs.

The researcher was positioned inside the Firm at consecutive time periods from October 2008 to October 2010. The relationship with the Firm changed thereafter and the research position shifted from insider to outsider until data collection stopped in October 2011. This reflective narrative therefore covers data collected from October 2008 to October 2011.

5.2.1 October 2008 to February 2009: Solid waste removal and Anaerobic Digestion

The researcher engaged with the Firm to participate in the work to develop and implement the Firm's Environmental Strategy (cf. 4.4). Work on this project was led by the Managing Director of the time (MD1) and involved a particular focus on resource management. The stated aim of this strategy was to identify and develop measures to improve resource productivity of factor inputs in production, e.g. vegetables, water use and energy consumption. This focus in the Firm accorded with the voluntary agreement established by FDF (cf. 4.3.2) to which the Firm was committed.

The Parent Group enrolled an advisor to facilitate the Group's work to meet this voluntary agreement and improve environmental performances. The Group Advisor (GA) was, before this new role, working as an operational director in another company in the group and had therefore a good understanding of food processing operations. The Group Advisor engaged with the Firm to facilitate work on the Firm's Environmental Strategy.

A distinct project led by the Group Advisor in the Firm identified the solid waste streams of organic materials arising from production. The organic waste streams include dry organic waste that is used as animal feed at local farms, and liquid waste (i.e. sludge from the water treatment plant) which is used as fertilizer on local farmland. The Firm pays for organic waste to be removed in this way. The GA identified a solution to make waste streams valuable to the Firm rather than paying for its disposal.

This solution involved an anaerobic digestion device known as an up-flow-anaerobic-sludge-blanket reactor[18]. This technology was identified by the GA in relation with a consultant specialised in organic waste treatment. This technology can be added to the Firm's existing water treatment plant. The principal function of this technology is (1) to facilitate the water treatment process of removing organic materials from water effluents, and (2) to transform the organic materials collected in this process into biogas. The biogas can then be used to produce and supply electricity to the factory. A summary of the environmental problem and solutions constructed is provided in table 5.2.

Table 5-2: October 2008 to February 2009

Environmental problem	**Environmental solution**	**Motivation**	**The main participants**
Solid organic waste removal and disposal	Up-flow-anaerobic-sludge-blanket-reactor (UASB)	Make waste valuable rather then paying for disposal	Group Advisor, Project Engineer Manager, Environment Officer, the Researcher, waste- treatment consultant

Work undertaken in the Firm to explore implementing this anaerobic digestion device included the Researcher, the Project Engineer Manager, the Water Engineer and the GA. This work involved a particular focus on the organic waste streams arising from the factory. The waste treatment consultant worked with participants in the Firm to map the organic waste streams. The purpose of this map was to identify the flow of organic waste arising from the factory and quantity of organic waste produced per day. The waste treatment consultant measured the quality of the organic waste streams so as to identify the potential for producing biogas and electricity. This assessment, undertaken by the

[18] For a review of this technology, see http://www.wur.nl/NR/rdonlyres/08A52B41-BF1D-4EBB-91B2-249173850DEC/80401/FactsheetUpflowAnaerobicSludgeBlanketReactorUASB.pdf

consultant, showed that the energy value[19] of the organic waste produced in the factory was not sufficient to justify investing in this anaerobic digestion technology. Hence, this solution identified by GA was abandoned.

5.2.2 November 2008: Electricity consumption in the Firm

The Project Engineer Manager identified that the cost of electricity consumption had recently increased in the Firm. The Firm's Health, Safety and Environment (HS&E) Manager was asked to address this matter concerning electricity cost in the Firm. The reason to enrol the HS&E Manager was because his role also included environmental management responsibilities. The HS&E Manager was responsible for the environmental regulations (e.g. the Climate Change Levy), and the voluntary agreement regarding environmental performance developed by the Food and Drink Federation (cf. section 4.3).

The HS&E Manager enrolled an energy consultant from the Carbon Trust to receive advice on how to reduce electricity use in the Firm. The energy consultant initiated a workshop in the Firm to improve the understanding of energy consumption associated with the Firm's operations. The participants in the workshop were the Project Engineer Manager, Production Manager, Technical staff, Raw Material Manager and the Researcher. The workshop participants identified refrigeration associated with production to be the main aspect of the Firm's energy consumption. The solution suggested by the energy consultant together with the workshop participants was to improve the understanding of temperature requirements of vegetable products throughout the production process. A summary of the environmental problem and solution constructed in this situation is provided in table 5.3.

[19] Energy value: the potential energy that can be converted from biodegradable material such as potato skin

Table 5-3: November 2008

Environmental problem	**Environmental Solution**	**Motivation**	**The main participants**
Electricity consumption	Improve refrigeration use in production	Reduce electricity cost in production	Project Engineer Manager, H&S Manager, Raw Material Manager, Technical staff, the Researcher, energy consultant

A key problem identified by the workshop participants was the individual refrigeration units in which certain vegetables are stored prior to production. Refrigeration used in this way to keep vegetables cool also involves materials that will later be solid waste, e.g. potato skins. From this insight, Project Engineer Manager posited a solution involving an in-line cooling system in production. This idea about in-line cooling includes a buffer zone in which peeled vegetables are stored prior to dicing and packaging.

This solution coincided with the Firm's overall strategy identified by MD1. This strategy emphasised a flexible production line that enable fast response to customers demands. However, this idea posited by Project Engineer Manager was not realised. He left the Firm in July 2009. Instead, a project initiated in August 2009 identified and completed a new refrigeration unit in the Firm. The purpose of this project was to replace smaller refrigeration units used for raw material storage. The new refrigeration unit was completed in September 2009 and contributed to reduced electricity consumption.

5.2.3 December 2008 to January 2009: Concerns about water use in the Firm

Water is used in the Firm to clean vegetables and protect these from contamination and deterioration throughout production. The water is abstracted from a borehole that is owned by the Firm. The amount of water that can be used by the Firm is regulated by the Environment Agency and detailed in a water abstraction license. This license provides participants in the Firm, e.g. the Water Engineer, with information about how much water the Firm can use on a daily basis. The Firm is therefore required, in accordance with this water abstraction license, to monitor water use. A water metering device is installed at the borehole to measure the amount of water used by the Firm. The Water Engineer keeps a record of the water used by the Firm based on information from this water metering device.

In addition to the abstraction license that regulates the input of water to the factory, the Firm owns and runs a water treatment plant to sanitise water effluent from production in the factory. The water treatment plant can therefore be described as an end-of-pipe technology. The sanitised water from this water treatment plant is discharged into a local stream. The water treatment and discharge is regulated by the EA and is detailed in a water discharge license. This license includes water quality standards required for discharges to the local stream.

Participants in the Firm, e.g. the Engineer Manager and the Water Engineer have, in response to this water discharge license, developed specific routines to monitor the water quality achieved in the water treatment process. A technical kit is used by the Water Engineer to identify the water quality requirements, which includes suspended solids[20] and BOD[21]. The water quality is also checked by a representative from the EA on a monthly basis. A summary of this environmental problem and solution is provided in table 5.4.

[20] Suspended solids: Mass of contaminant per tonne of product or m^3 of effluent water
[21] Biological Oxygen Demand: Amount of BOD, (in kg) per tonne of product or m^3 effluent water

Table 5-4: December 2008 to January 2009

Environmental problem	Environmental Solution	Motivation	The main participants
Water effluents that arise from water used in production	Water treatment plant	Compliance with the water discharge license	The Water Engineer, the Project Engineer Manager, the EA representative

Concerns about increasing water use in the Firm were articulated by MD1 and the Project Engineer Manager, which led to a project focusing on water use. This concern built on information about water use provided by the Water Engineer who records water use on a daily basis. The Water Engineer found that water use in production had increased during the past few weeks. This increase in water use put pressure on the water treatment plant, which was now working to the upper limit of its capacity. MD1 enrolled the Group Advisor (GA) to assist in this project to resolve this problem of water use in the Firm. The following section provides details about a project focusing on the Firm's water treatment capacity

5.2.4 January 2009: Project initiated to resolve water treatment capacity

The GA enrolled a water treatment consultant to complete an assessment of the water treatment plant. The purpose of this assessment, undertaken by the water treatment consultant, was to identify and evaluate the options available to the Firm to resolve the problem of water treatment capacity. Work undertaken in the Firm to identify options to resolve this problem focused on this end-of-pipe technology. The water treatment consultant worked together with participants in the Firm, e.g. the Project Engineer Manager, the Water Engineer and the Researcher. This project identified options available to the Firm to improve the capacity of the water treatment plant.

The water treatment consultant presented the options available to the Firm in a plan for action, which involved two components; these were:

- a set of initial measures to improve the water treatment plant in the short term, and
- consider installing a Membrane-Bio-Reactor (MBR) as an additional device that can be attached to the existing water treatment plant.

The principal function of the MBR technology is the opportunity it presents to facilitate the water treatment process as to enhance the water quality, and recycle the water back into the factory and use it in certain grey areas with lower hygiene requirements[22].

The initial set of short-term measures recommended by the water treatment consultant identified the following options:

- to improve the management of the water treatment process to optimise its capacity such as developing daily operational protocols;
- upgrading technical devices (e.g. sieves, centrifuges and settling tanks) in the water treatment process to make these work more efficiently and effectively, and
- upgrading the chemical dosing system that is used to facilitate the water treatment process.

The second component in the plan for action to address water use recommended by the consultant involved installing a MBR. This technological device has three advantages:

[22] An account of a MBR can be found at http://www.tsgwater.com/pdf/MBR%20Synopsis.pdf

- it is practically easy to install as it can be attached to the existing water treatment plant;
- it holds the potential to sanitise water to potable quality, and
- water sanitised in this way can be recycled back to production.

Hence, this solution was seen to hold the potential to overcome the constraints to water use imposed by the water abstraction licence. In other words, installing a MBR can help the Firm to solve issues of water use if water demand were to increase in the future. This could be important if business growth led to more production and required more water. However, the MBR is an expensive technology requiring a big upfront investment including the running cost (e.g. electricity consumption). A summary of the environmental problem and solution constructed in this situation in provided in table 5.5.

Table 5-5: December 2008 to January 2009

Environmental problem	**Environmental Solution**	**Motivation**	**The main participants**
Water use and treatment	Short term upgrade of Water treatment plant. Water Recycle via MBR technology in the longer term	Water availability and treatment	Group Advisor, Engineers, Consultant, Researcher, technology providers

The water project led by the Group Advisor focused on the water treatment plant. This project largely identified end-of-pipe measures to solve problems of water use. The solutions focused on end-of-pipe comprised both short term and long term initiatives. While the short term measures involved quick fixes, the long term measure required a large investment in MBR technology. The MBR was seen as an attractive technology, according to MD1, as it supported his plans for business growth. However others, e.g. the resource controllers at the Parent Group, were not convinced.

The Group Advisor evaluated the MBR using an investment appraisal. This included setting the cost of the investment against the potential benefits it could provide the Firm. The benefits of using MBR were identified in monetary terms. For this purpose, the Researcher and an Engineer identified the current cost of the Firm's water use, which included both water abstraction and treatment costs. The cost of water and potential savings that could result from installing MBR technology were identified as low. Based on this investment appraisal, the Group Adviser estimated the payback on this investment to be 10 years. However, the resource controllers at the Parent Group argued that this could not be accepted from a financial perspective. Hence, at this point, MBR technology was not considered a priority.

The short term fixes identified to upgrade the water treatment plant were realised in June 2009, which are described in section 5.2.7. Problems around water use were not only constructed around water treatment capacity. Participants in the Firm, e.g. the Project Engineer Manager, tried to reduce water use in production. Details about this project are provided in the following section.

5.2.5 February 2009: Reducing water use in production

Concerns about the Firm's water use, described above, required measures to reduce water use in production. A project was initiated in the Firm led by the Engineer Manager. The rationale was to ease the pressure on the water treatment plant by identifying and implementing cleaner production measures that saved water. The focus on cleaner production measures is different from end-of-pipe as it focuses on the root cause of the issues of water use in the Firm. However, replacing end-of-pipe technology (e.g. the water treatment plant) with cleaner production methods was not seen as an option because of practical reasons. This would have required a costly total re-design of the Factory, which was not financially possible. Instead, this approach focusing on cleaner production measures emerged in addition to the project focusing on end-of-pipe measures.

The Water Engineer and the Project Engineer Manager in the Firm's engineering department has particular experience and knowledge about the infrastructure of water and how water is used in production. This includes knowledge about how water is supplied to the factory via the borehole, water pipes and water pumps, and how water pipes are linked to the various activities in production. The engineering department were therefore responsible for managing issues of water use in production. This was important for two reasons: (1) to ensure that the Firm does not exceed its water abstraction license, and (2) to ensure that the water use in production does not exceed the capacity of the water treatment plant.

One way to achieve control in this respect was to establish a Water Balance Framework. This was identified by the Researcher at a workshop organised by the UK Food and Drink Federation as part of their environmental project in food industries. The purpose of developing a Water Balance Framework is to identify water inputs, water use activities, and water outputs at particular times, e.g. a day, a week or a year. The Water Balance represents a 'snap-shot', which reflects typical water use in an organisation. The Researcher worked with the Water Engineer to develop a Water Balance for the Firm. Details about the Water Balance are provided in Figure 5.1.

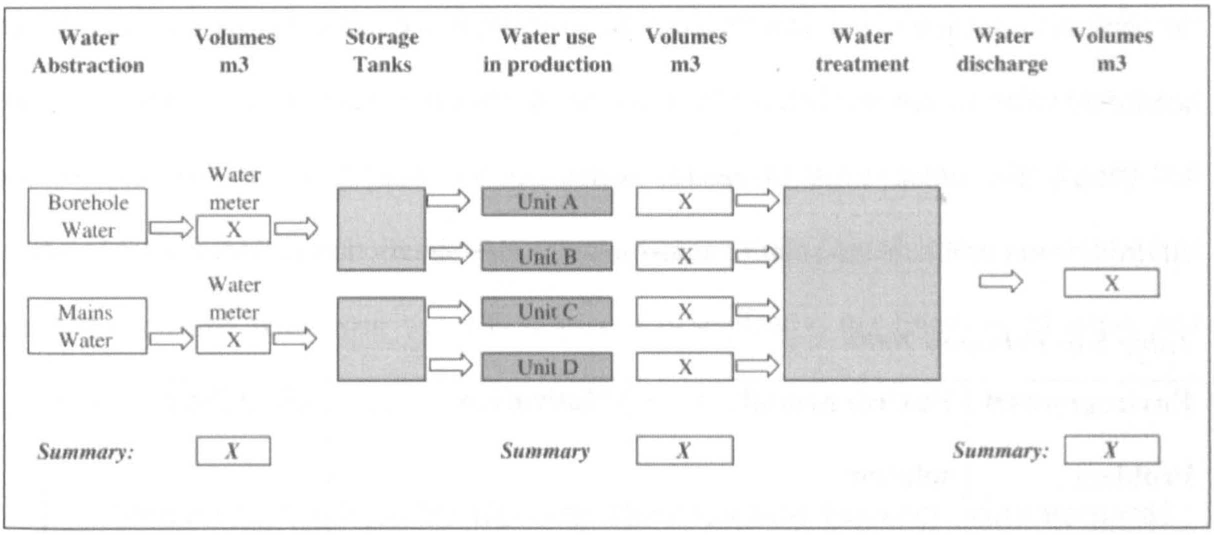

Figure 5-1: An illustration of the water balance template developed in the Firm (own development based on insight from the Firm)

In this project to identify the Firm's water balance, the Researcher and the Water Engineer used onsite water metering devices to record water inputs and outputs. There is one water meter located at the borehole and there are additional water meters located in the factory to record specific water-using activities in production. The Water Engineer kept a record of daily water meter readings, which has been a procedure for a long time in the Firm. Hence, the Water Engineer possessed knowledge about how much water the Firm was using on a daily basis. However, there was no established procedure in the Firm for communicating this information to other participants in the Firm, e.g. production, about water use collected by the Water Engineer.

Participants in production (e.g. production staff), did not have any insight about water use. This was a problem identified by the Researcher and the Water Engineer, because if the people actually using the water do not know how much they use, then how could they reduce it? The Water Engineer developed a water balance framework in response to this problem. This framework helped the participants in this project to make sense of water use in production. The underlying rationale was, according to the Project Engineer Manager:

'if you can't measure it, you can't manage it'. By adopting this framework, the participants identified where water was being used and how much was used at particular times in order to identify the quick wins to reduce water use in production. A summary of the environmental problem and solution constructed in this situation is provided in table 5.6.

Table 5-6: February 2009

Environmental Problem	**Environmental solution**	**Motivation**	**Main Participants**
Water use in production	Identify the Firms Water Balance in terms of water inputs, water use activities and water outputs	Reduce water use in production, which also help reduce the pressure on the water treatment	The Engineer, the Researcher, the Project Engineer Manager, the FDF

Participants, e.g. the Project Engineer Manager and the Researcher, identified that the water used by production staff to clean food processing machines could usefully be reduced. Production staff in the factory use drop-down water hose-pipes that are accessible at each machine for this purpose. The problem with these water hose-pipes, according to the Project Engineer Manager, was the dimension of the pipes combined with the pressure of water. These two factors combined were seen as an inefficient way to clean food processing machines during production. Hence, the Project Engineer Manager identified water hose pipes which were narrower in order to enhance the effect of water being used for cleaning, while less water is actually being used.

Additionally, to enhance the efficiency of water used in this way the Project Engineer Manager identified water pressure nozzles. This solution included water guns attached to the end of the drop-down water hose-pipe. Water guns are used by the hygiene team to clean the whole factory during the nightshift, but are not used by production staff. A number of water guns were therefore installed in the factory, which were of a different kind to those used by the hygiene team. However, staff in production did not find the water guns useful to clean food processing machines during the production. They argued that these devices were less effective to clean food processing machines because more time was needed compared with open water hose-pipe. Consequently, the Engineer Manager and production shift managers agreed to remove the water guns used by production.

5.2.6 March to April 2009: Re-Organisation and Factory Management Framework

In this period, the Operational Director was struggling to realise the potential of production in the Factory. The lean manufacturing framework (described in section 4.4.1) developed for this purpose had failed according to MD1. The ambition to establish lean manufacturing focused too much on performances of production yields, while other factors affecting yields, e.g. knowledge and capability of production staff to transform raw material into products, received less attention. These challenges of achieving production performances led to changes in the management of production. MD1 appointed new actors in leading positions. This included a Factory Manager, an interim operational director, Engineering Manager and Production Manager. The Operational Director and Engineering Manager left the Firm.

A Factory Manager was enrolled to take leadership in production. The Lean Manufacturing Framework was abandoned and a new way of organising production emerged. The new approach was less concerned with ways to measure yields of all the production lines, which was the ambition of the former framework. Instead, a new set of performance indicators was identified in a Factory Management Framework. This was developed by the new Factory Manager together with other members of senior staff including MD1.

This Factory Management Framework was entitled 'Daily Reviews' and included, among other things, the following performances required: good manufacturing practice, customer service and solid waste streams, as detailed in Table 5.7.

Table 5-7: The Daily Review framework (Adopted from the Firm and modified by the Researcher)

Performance required in Factory Management framework	**Performance description**
Health and safety	Accidents or near misses
Customer complaints	Product defects reported by customer
Good Manufacturing Practice	Hazard Analysis and Critical Control Points: legal requirements to prevent wrongdoing in food manufacturing
Solid Waste	Daily record of solid waste removal
Customer service	Make sure products are delivered in full and on time to customers
Labour hours in production	Labour productivity
Engineering	Production downtime because of machine failure
Focus performance required	Performances not part of daily review, but needs specific attention, e.g. water use.

These required performances were monitored by participants in the Firm with a responsibility and accountability necessary to gather requisite information and report on a daily basis. The information on required performances was reported at production meetings. These were held every morning in an office inside the Factory. Participants from each department got together in these meetings reporting on the identified performances, which were based on data from the previous day.

Following this insight it was suggested by the Researcher that a focus on environmental performances (e.g. water use in production) could be introduced in this Daily Review Framework and reported in the production meetings. The former approach identified to resolve issues of water use in production, described in section 5.2.4, had failed. One of the reasons why this failed, according to the Researcher, was that issues of water use received little attention by the managers of production at that time. Factory Manager (FM1) identified water use as a key performance in production. In this way, water used received more attention among production staff in the factory. A summary of the environmental problem and solution constructed in this situation is provided in table 5.8.

Table 5-8: March to April 2009

Environmental problem	**Environmental solution**	**Motivation**	**Main Participants**
Water use in production	Integrate water use as performance required by Factory Management Framework	Reduce water use in production, which also help reduce the pressure on the water treatment	The Engineer, the Researcher, the Factory Manager 1, Production Staff

The Operational Director was not involved in finding ways to reduce water use, as this was not a performance required in the lean manufacturing framework. By contrast, the new Factory Management Framework involved a broader set of performance indicators. It was suggested by the Researcher that water use could usefully be a performance requirement. This way, water use could potentially receive more attention in production where water is actually being used. A focus on water use in production could help the participants in the Firm to identify and implement cleaner production measures. This can provide potential benefits to the Firm as it can reduce the pressure on end-of-pipe fixes, particularly the water treatment plant.

5.2.7 June to August 2009: Struggle to go beyond end-of-pipe fixes to address issues of water use

The project led by the Group Advisor focusing on water treatment capacity described in section 5.2.4 had identified a number of ways to upgrade the water treatment plant. The initial set of measures identified by the consultant were adopted by the Project Engineer Manager because the Group Advisor had left the Firm. The Project Engineer Manager developed a plan of action to upgrade the Water Treatment Plant. This plan for action included a number of short term technical fixes: larger and more efficient water pumps, adjustments of the mechanical stage of the treatment process and upgrades of the water holding tanks. The water holding tanks were particularly important to upgrade as these can constrain the treatment capacity. Thus, more space for water tanks provide the treatment process with both volume capacity and time for the plant to sanitise water. These actions are summarised in Table 5.9.

Table 5-9: June to August 2009

Environmental Problem	**Environmental solution**	**Motivation**	**Main Participants**
Water treatment capacity with respect to time and volume	Quick technical fixes: upgrade water holding tank and improve performance of mechanical treatment	Secure water treatment performance required by production.	Project Engineer Manager, The Engineer, the Researcher, MD1, Contractor doing the ground work,

These solutions described above provided the Firm with greater water treatment capacity, which secured the ability to cope with peak flows arising from production. However, the Researcher and Supervisor 1 drew the Firm's attention to the danger of expanding end-of-pipe measures in this way. Focusing on end-of-pipe alone can become an ever increasing investment, which involves both existing running cost and additional cost when increased capacity is needed. Cleaner production initiatives could not only hold the potential to reduce the pressure on the end-of-pipe measure, but also avoid future costs. In other words, cleaner production measures could be more cost-effective in the longer term.

Following this insight by Supervisor 1 and the Researcher, a project was suggested to reduce water use in production. This project was initiated in a Steering Group led by the Managing Director (MD1). The purpose of this steering group was to facilitate the implementation of the Firm's Environmental Strategy. MD1 invited Supervisor 1, Factory Manager and Technical Director to participate. The intention was for the participants to meet on a monthly basis to prioritise work identified in the Environmental Strategy and ensure that necessary resources are made available to realise these.

The method identified to implement aspects of the Firm's Environmental Strategy (e.g. reducing water use) was suggested by Supervisor 1 and the Researcher. This built on the Action Research method (described in appendix C). In broad terms, AR is a method to solve specific problems with local participants and can be described as a learning process that follows prescribed steps. The steps in AR includes: (1) identify the problem, (2) identify a solution, (3) implement solution, (4) reflection on the change realised and decide what to do next.

The project concerned with water use involved a particular focus on measures going beyond end-of-pipe fixes, i.e. cleaner production approaches. A focus group with a specific remit to address water use in the firm (hereafter referred to as the Water Group) was established and involved the Researcher, Engineering Manager, Production Manager, an MSc Student, and the Hygiene Manager. Initially, the Water Group explored measures to reduce water use and a number of changes were subsequently introduced. This is summarised in Table 5.10.

Table 5-10: June to August 2009

Environmental Problem	**Environmental solution**	**Motivation**	**Main participants**
Water use in Production	Establish Water Group with specific remit to address water use in production	Reduce water use, reduce pressure on the water treatment plant	The researcher, the Engineering Manager, the Production Manager, the Hygiene Manager, MSc student, MD1 and the Steering Group

It was suggested by the Water Group that water use could usefully be a performance required in production. Following this suggestion, the Production Managers began addressing ways to reduce water use in production. For example, a different way to clean the factory floor was identified by Production Managers. Instead of using the drop-down water hose-pipes to rinse the floor, they introduced squeegees and shovels to remove vegetable waste from the floors around the factory. This involved a new way to clean the floor in which solid waste is swept up using shovel and disposed in a designated container.

A summary of the environmental problem and solution constructed in this situation is provided in Table 5.11. However, although new measures (e.g. squeegees and shovels and daily reporting of water use to production) were established, it was not seen to contribute to any significant reductions of water use. The Water Engineer who was responsible for water meter readings did not identify any less use of water in production.

Table 5-11: June to August 2009

Environmental problem	Environmental Solution	Motivation	Main participants
Water use in production	Water use performance required in production; different way to clean factory floor	Reduce water use in production, reduce pressure on water treatment plant	The Engineer, the Researcher, Production Manager, MSc Student, Hygiene Manager, MD1 and Steering Group

It was argued by the Engineer responsible for the water treatment plant that production staff was seen to require more water for their activities rather than seeking ways to reduce their water use. It was also noted by the Researcher that the reporting of water performances in production meetings did not make sense to production staff as they could not relate to what the figures meant. The Researcher noted this from interacting with both production staff and the engineering community. The engineers had experience and knowledge about the Water Treatment Plant regarding its capacity. However, the water treatment plant is somewhat detached from the Factory and those running it.

The water treatment plant is situated a few hundred yards behind the factory in a place where production staffs rarely go. Furthermore, for food safety reasons, production staff are advised not to visit places that can involve a risk of contamination being brought into production. Hence, the majority of the production staff have never seen the water treatment plant and know very little about the water use beyond production. The engineers on the other hand who have knowledge about the water treatment plant also know why it is important to reduce water use in production. These actions and those involved are shown in Table 5.12.

Table 5-12: June to August 2009

Environmental Problem	Environmental Solution	Motivation	Main participants
Water use in production	Inform production staff about water use and create awareness why water use needs reducing	Reduce water use in production, reduce pressure on water treatment plant	The Engineer, the Researcher, Production Manager, MSc Student, Hygiene Manager, MD1 and Steering Group

The Researcher identified a gap in understanding water use in the Firm between the Firm's production staff and the engineering community. This gap was particular apparent during a disagreement that arose around a food processing machine in the factory. The amount of water supplied to the machine was regulated through a water valve attached to the machine. The production staff working with the machine to produce products wanted a higher water pressure supplied to the machine so as to facilitate production, while the engineers wanted a lower pressure as to ease pressure on the water treatment plant.

Following this insight by the Researcher, the Water Group began to develop a water information campaign. The purpose of this measure was to inform production staff about water use and to make sense of why this performance is important to address. The work on this campaign was carried out by the Water Group. This measure was realised in October 2009, and is described in greater detail in section 5.2.9.

5.2.8 September 2009: The Environmental Strategy struggles to form part of the new Firm image

The Environmental Strategy formed part of the Firm's overall strategy, which aimed for business growth. MD1 saw the potential of making the Firm appear more attractive to customers by making the Environmental Strategy more visible, both internally to the Firm but also to externally outside the Firm. At this point, the Firm was working with a Marketing Consultant enrolled by MD1 to give advice on creating a new Firm image. The purpose was to identify the content of the Firm's image: what is their unique selling point, and promote this to others such as customers.

The work on Firm's image was a long term project that had been going on for some time. MD1 was pursuing the Environmental Strategy as one of the main commercial messages to customers. However, this view was challenged by the Marketing Consultant. They argued that the quality aspect of products was more important to focus on in this sector. Hence, the environmental image could form part of the Firm image as long as it did not detract from marketing messages concerning quality.

This imposed a commercial concern on the rational for the Environmental Strategy. At the following Steering Group meeting for the implementation of the Environmental Strategy, participants discussed the rationale for subsequent action. It appeared that the participants in the Firm shared the view of the Marketing Consultant. For example, the new Sales Director appointed by MD1 had insights on these matters based on commercial experience in the food industry. In his view, customers (e.g. ready meal manufacturers) were not, at this time, interested in the Environmental Strategy. Instead, customers were found to be more interested in product price and product quality. Hence, there was a danger, according to the Sales Director that a 'green' image may be perceived by the Firm's customers as an additional cost rather than a project that involves cost savings.

Following this event, participants in the Steering Group agreed to focus on projects that could improve resource productivity. This includes a priority of cleaner production measures (e.g. make more efficient use of resources in production). This approach was coined by MD1 as 'Greener and Leaner'. This involved a particular focus on resources (e.g. raw materials, water and energy) used in production and ways to reduce these. The rationale for this focus was to reduce the cost of factor inputs. This approach is summarised in Table 5.13.

Table 5-13: September 2009

Environmental Problem	**Environmental solution**	**Motivation**	**Main participants**
Natural resource use in the Firm: vegetables, energy and water	Establish a strategy that focus on greener and leaner:	Reduce cost of factor inputs: raw material, water and energy	MD1, FM1, the Researcher, Supervisor 1, Sales Director

A key priority in the Firm at this time was production focusing on vegetable throughputs. Work to improve production throughput was led by the Factory Manager (FM1) and described in section 5.2.10. Water use was another priority in the Firm's 'Greener and Leaner' programme. The following section describes the cleaner production measures identified by the Water Group to reduce water use in production.

5.2.9 October 2009: Water Group developed initiative to reduce water use in production

The Water Group (cf. 5.2.9) identified cleaner production measures to reduce water use in production. A key insight developed in the Water Group was that production Staff using water in production had limited understanding about constraints to water use imposed by both water abstraction license and the water treatment capacity. A cleaner production measure identified in this respect was to inform production staff about water use. This included two interlinked components. First, an informative poster of what constitutes good water use practices in the factory. An illustration of this poster is provided in Figure 5.2. Second, a guided tour for production staff aimed to them to learn about the Firm's water abstraction, water treatment and water discharge.

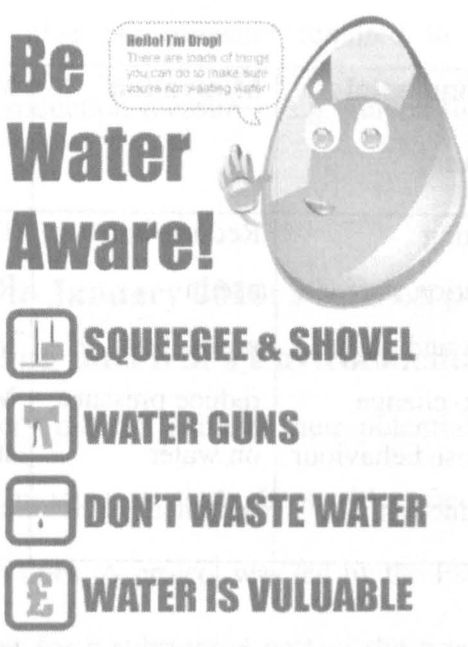

Figure 5-2: Poster developed in the Firm about water use (adopted from the Firm)

The water poster developed by the Water Group in liaison with the Marketing Consultant involved both a visual representation and text of what constitutes good practices around water use in production. The purpose was to change staff behaviour with regards to water use. More specifically, this included:

- production staff should report any misuse of water (e.g. leaking water pipes);
- production staff should use water only when needed (e.g. cleaning raw materials and machines), while using other means (e.g. squeegees and shovels to clean solid waste from the floor), and
- information about the value of water in monetary terms.

The posters were developed in two languages, English and Polish (a number of the production staff were Polish), and put on walls around the Factory. A summary of the problem and solution constructed in this situation is provided in table 5.14.

Table 5-14: October 2009

Environmental problem	**Environmental solutions**	**Motivation**	**Main participants**
Water use in production	Informing production staff via posters and guided tours to change water use behaviour in production	Reduce water use in production, reduce pressure on water treatment plant	The Engineer, the Researcher, Production Manager, Hygiene Manager, production staff, Marketing consultant

As noted in Table 5.14, above, the second component to change staff behaviour was the concept of a guided tour. The purpose of this was to inform production staff about the Firm's water supply and treatment. It was argued by the Researcher that this could provide production staff with a better understanding to why it is important to reduce water use in production. The guided tour was designed by the Water Group and involved a tour led by the Factory Manager and Engineer. The guided tour informed production staff about water abstraction, water treatment and water discharge.

This measure was much appreciated by production staff as they had never seen either the borehole from which the Firm's water is sourced, nor had they seen the water treatment plant and where the water is discharged. Although the Factory Manager and the Engineer viewed this concept as a successful measure to raise awareness about water use in production and to encourage improvements in water use performances, only three sessions were carried out. One of the main reasons why the guided tour did not continue was other priorities in production. A guided tour involving members of production staff disrupted both production activities, which were under constant pressure to produce finished products on time. Hence, other performances required in the Firm (e.g. production throughput) made cleaner production measures (e.g. guided tours) difficult to pursue and so they thus were ended.

5.2.10 November 2009 to January 2010: Focus on production throughput leads to abandoning the Firm's Environmental Strategy

The operations in the factory did not achieve their potential according to the Factory Manager. Concerns about production throughputs identified a need to improve the efficiency of key production lines. A project was led by the Factory Manager focusing on production lines that account for a substantial part of the product volumes. The Factory Manager identified the key participants in the Firm to take part in this project. The participants enrolled were the Engineer Manager, Production Manager, Procurement Manager, Technical Manager, Raw Material Manger, sales manager and Warehouse Manager.

The participants met on a weekly basis and tried to identify and implement measures to improve production throughput. The measures identified in these meetings to achieve this included, among other things:

- procurement of vegetables with particular emphasis on size appropriate to the food processing machines in the factory;
- identify efficiency measures in production so as to enhance vegetable throughput in key product lines, and
- improve customer service in terms of delivery of finished products to the Firm's customers. A summary of the (environmental) problem and solution in this situation is provided in table 5.15.

Table 5-15: November 2009 to January 2010

Environmental problem	Environmental Solution	Motivation	Main participants
Production throughput	Identify and implement measures in production as to improve production throughputs	Cost of vegetable input and profitability	FM1, MD1, the Engineer Manager, Production Manager, Procurement Manager, Technical Manager, Raw Material Manger, sales manager and Warehouse Manager

This focus on production throughput led by the Factory Manager identified a number of short term measures that were implemented in the Firm's operation. Among other things, the engineering department improved a number of production lines to enhance production throughput. For example, spillage points in the factory were addressed to prevent vegetables falling off the production line. This focus on short term measures was at odds with the Environmental Strategy identified by MD1.

The Environmental Strategy involved a particular focus on resource productivity and ways to achieve this in the Firm. However, the focus on production throughput and the project led by the Factory Manager drew the attention away from the Environmental Strategy. The Environmental Strategy was seen as irrelevant at this time in the Firm. For example, the Procurement Director argued that product throughput and product price were the key issues that needed to be addressed in the Firm. Moreover, the MD1 was in doubt about the Environmental Strategy, which was revealed in a steering group meeting during a discussion about the Firm's ability to implement this strategy.

The priorities in the Firm at this time were production throughput. It was found essential to enhance the efficiency of key product lines so as to maintain profitability in the Firm. Work undertaken in the Firm to achieve this was led by the Factory Manager and focused on measures involving operations in the factory in the shorter term. It was therefore decided by the Factory Manager and other participants in the steering group that the Environmental Strategy should be 'put on hold'. In order to improve the operations in the Firm's production, the Parent Group found it necessary to enrol a different managing director (i.e. MD2). MD2 was before this appointment working as operational director in another company part of the Group and was therefore seen suitable to help the Firm to improve production throughput.

5.2.11 February 2010: A new Operational Framework developed

The MD2 was appointed as interim manager to lead the Firm. Factory Manager (FM1) was enrolled to lead work undertaken in another company in the Group. A new Factory

Manager (FM2) was enrolled to organise the work in the Firm's production. FM2 worked with other participants involved in production throughput, e.g. Planning Manager and Production Manager, to improve aspects of the Firm's operations. In broad terms, this work focused on performances required to produce pre-cut vegetables and deliver these to customers. The Daily Review framework developed by FM1 was used as template to organise production.

FM2 introduced changes in the organization around production in the factory which included a greater emphasis on key functions and performance indicators. This new development in the Firm involved a number of detailed frameworks for each department, e.g. production, engineering, technical and transport and performances required. FM2 identified and developed a new Operational Framework together with participants involved in production. This framework identified an overview of the key performances required in production and supply of pre-cut vegetables. A key development in the Firm at this time was the introduction of a large white 'NOBO board' in the operational meeting room.

This NOBO board was used as an organising device, enabling participants in production to measure and monitor performances required on a daily basis. The NOBO board was designed by the FM2 together with other participants to enable each key performance indicator to appear across a week and to allow comparison between days. The NOBO board helped structuring the production meetings and engaged many participants to organise the work in production. A summary of the (environmental) problem and solution constructed in this situation is provided in table 5.16.

Table 5-16: February 2010

Environmental problem	**Environmental Solution**	**Motivation**	**Main participants**
Production throughput	Operational Framework, including the NOBO board, to organise performances required in production	Cost of vegetable input and profitability	FM2, MD2, the Planning manager, the Engineer Manager, Production Manager, Procurement Manager, Technical Manager, Raw Material Manger, sales manager and Warehouse Manager

The measuring and monitoring of key performances on a daily basis informed the participants to prioritise what performances needed attention. For example, if the production manager detected a downturn in production yields, this information was shared with other participants to try to find out what is causing this downturn and address any identified problem swiftly.

5.2.12 March 2010: Appointment of Environmental Officer and development of Environmental Reporting Framework

Managing Director 2 and Factory Manager 2 enrolled the Water Engineer as Environmental Officer in the Firm. This person was previously responsible for the Firm's water treatment plant. This experience provided the new Environment Officer with knowledge about the Firm's end-of-pipe measures. This included in particular water treatment, but also knowledge about the solid waste streams and disposal. This knowledge was found suitable for being Environment Officer according to FM2.

The purpose of developing this new environmental responsibility in the Firm was to concentrate into one role all environmental regulations facing the Firm, i.e. water, waste and energy regulations. This involved a particular focus on the water treatment plant and the removal and disposal of waste streams. The waste streams included solid waste, which were disposed of as animal feed; recyclable waste, which included paper, cardboards and wooden pallets; and landfill waste, which included contaminated plastics. The Environment Officer also became responsible for the voluntary agreement with respect to environmental performances (e.g. water, waste and energy) developed by the Food and Drink Federation.

The Environment Officer and the Researcher were asked by FM2 to organise the Firm's performances required in light of environmental regulation and the voluntary agreement. The Environment Officer and Researcher identified the following environmental performances in light of the Firm's operations: energy consumption, water use and solid waste streams. A summary of the environmental problem and solution constructed in this situation is provided in Table 5.17.

Table 5-17: March: 2010

Environmental Problem	**Environmental Solution**	**Motivation**	**Main participants**
Natural resource use in the Firm: raw materials, energy and water	Environmental Officer enrolled to develop Environmental Performance Framework	Reduce cost of factor input; ensure compliance with environmental regulation and FDF voluntary agreement	The Environmental Officer, FM2, the Researcher, MD2, FDF, the EA

Participants involved in this project to identify the Firm's environmental performances requirements developed an Environmental Reporting Framework. This framework, illustrated in Table 5.18, was designed to measure and monitor the environmental performances required on a daily basis. The focus on daily performances was encouraged by FM2. The underlying rationale for this daily reporting routine was to make the monitoring of environmental performances compatible with performances identified in the overall Operational Framework. Information about the Firm's environmental performance was collected by the Environmental Officer and reported to Factory Manager 2.

Table 5-18: Environmental Reporting Framework developed by Environment Officer (Adopted from the Firm)

Environmental performances identified	Performances and reporting
Water use	Daily monitoring of water abstraction meter
Energy consumption	Daily monitoring of the on site electricity meter
Solid Waste removal and disposal	Daily recording of solid waste disposed off site: animal feed, sludge, recycled, landfill
Water treatment	Daily monitoring of water discharged to local brook

This environmental performance framework was developed in an excel spreadsheet. A blank illustration of this framework is provided in Figure 5.3.

Environmental Performance Summary

		WE	WE	WE	WE
Item -Summary	**Target**	**01-May**	**08-May**	**15-May**	**22-May**
Finished Product (KG)					
Finished Product (tonnes)					

Water Use (m3)					
Water efficiency (m3/tonnes)					
Electricity use (kWh)					
Electricity efficiency (kWh/ t FP)					

Vegetable by-product Animalfeed					
Unit A					
Unit B					
Unit C					
Unit D					
Vegetable by-product: Summary					
Total Material FP + By-Product					
Production By-product/FP (%)					

Landfill (KG)					
Recycling (KG)					

Transport (KM)					
Tranpsort efficiency (KM/t of FP)					

Legend
KM: Kilo Meter
m3: Cubic Meter
kWh: Kilo Watt Hours
FP: Finished Products
WE: Week Ending

Figure 5-3: The environmental performance framework developed in the Firm (Adopted from the Firm)

The work carried out by the Environment Officer provided the Firm with the ability to identify and pursue improvements of environmental performance. An important factor in this respect was the knowledge and experience of the Environment Officer from preceding responsibilities around water use and treatment. This experience, combined with this new role, provided the Firm with a useful link between end-of-pipe measures (e.g. water treatment plant) and production. The Environmental Officer had good insight in both end-of-pipe and production, which was helpful to identify cleaner production measures that could reduce water use in production and ease the pressure on end-of-pipe.

5.2.13 April to May 2010: Cleaner production measures identified and implemented to reduce water use in production

The Environment Officer worked with the FM2 to identify and implement cleaner production measures with the purpose to reduce water use in production and ease pressure on end-of-pipe functions. The information provided by the Environment Officer was presented in text and graphs about water use in the Firm. For example, in accounting for the cost of water, the Environment Officer identified water abstraction cost, energy cost, chemical cost and maintenance cost. This information was summarised in a diagram and identified the average cost of using a cubic meter of water in the Firm. Moreover, daily water use was presented in a graph showing how much water was used per day and over time. This information justified two projects, led by the Environment Officer and the Hygiene Manager, and initiated to achieve reduced water use.

The first project stemmed from identifying that the cleaning of the Factory was a major water user in the Firm. The Hygiene Manager and the Engineering Manager identified a way to make cleaning activities more efficient. This included an installation of a separate water infrastructure, e.g. water holding tank and water pump, which could only be used by the cleaners. Separating the water used in production from the water used by the cleaners provided the latter with an ability to oversee their own water use (e.g. pressure on pump, temperature and chemicals used).

The second project came as the Environmental Officer identified an opportunity to circulate and reuse water in one of the food processing machines. The company who designed the machine was contacted and asked to construct a water circulation device that could be installed to the machine in the Firm. A summary of the environmental problem and solution constructed in this situation is provided in Table 5.19.

Table 5-19: April to May 2010

Environmental Problem	**Environmental solution**	**Motivation**	**Main participants**
Water use in production	Develop a separate infrastructure for water supplied to cleaners; install a water recirculation device on a food processing machine	Reduce cost of water use and reduce pressure on water treatment plant	The Environmental Officer, FM2, Hygiene Manager, food processing machine company

The two projects identified to address water use in the Firm helped to make a significant reduction to the Firm's water use. However, these two projects involved technical fixes and required therefore little involvement from other participants in the Firm to achieve this. The Researcher and the Environment Officer found that more engagement from other participants in the Firm was needed to achieve further improvements of the Firm's environmental performances. This insight was shared with the FM2 and a project was initiated to achieve a better integration of the Firm's Environmental Reporting Framework and the overall Operational Framework.

5.2.14 May 2010: Integrating the Firm's Environmental Reporting Framework with the overall Operational Framework

Work undertaken in the Firm involving the Environmental Reporting Framework was found contained with the remit of the Environment Officer, with little integration with the overall Operational Framework. A project was initiated by FM2 and enrolled the Environment Officer to integrate the Environmental Reporting Framework with the overall Operational Framework. The Researcher participated in this project. The participants in this project found that there was no procedure in place to communicate the information about the Firm's environmental performances to other participants in the Firm. This insight was shared with the FM2 who noted that other participants in production did not account for environmental performances in their activities.

In response to this problem, the Researcher and the Environment Officer found that a shift in responsibility was needed to achieve further improvement in the Firm's environmental performances. For example, the person responsible for reporting water use was the Environment Officer and not the production manager responsible for production in which the water is used. It was therefore suggested by the Researcher that a shift in responsibility around water from the Environment Officer to the Production Manager would increase the engagement of the latter and thereby integrate this environmental performance with production. A summary of the environmental problem and solution constructed in this situation is provided in table 5.20.

Table 5-20: May 2010

Environmental Problem	**Environmental solution**	**Motivation**	**Main participants**
Work to address environmental performances involved limited integration with the overall Operational Framework	Engage key participants in the Firm achieve further improvements of the Firm's environmental performances	Reduce cost of factor inputs, ensure compliance with environmental regulation and FDF voluntary agreement	The Environment Officer, the Researcher, The FM2

Work undertaken by the Environment Officer to integrate the identified environmental performances with the overall Operational Framework did not proceed as the participants in this project expected. For example, a shift in responsibility from the Environment Officer to Production Manager to report water use was not achieved. It was argued by FM2 that key participants involved in production did not understand the importance of the environmental performances identified. Following this insight, it was suggested by Supervisors 1, 2 and the Researcher that a workshop involving key participants in the Firm could facilitate the integration of the Environmental Reporting Framework with the overall Operational framework.

5.2.15 June 2010: workshop to engage key participants in the Firm in the work on environmental performances

A workshop was carried out in the Firm led by the Researcher, Supervisors 1 & 2, the Environment Officer and Factory Manager 2 (see Appendix C for details about this workshop). The Firm's managers invited to the workshop represented each functional department: engineering, finance, production, procurement and technical. The purpose of the workshop was to inform the Firm managers about the environmental performances required, and subsequently prioritise what environmental performances to pursue in Firm. A summary of the environmental problem and solution constructed in this situation is provided in table 5.21.

Table 5-21: June 2010

Environmental problem	**Environmental solution**	**Motivation**	**Main participants**
Environmental performances not integrated in the Firm's overall Operational Framework	undertake workshop to inform key participants in the Firm about environmental performances required	Reduce cost of factor input; ensure compliance with environmental regulation and FDF voluntary agreement	The Environmental Officer, FM2, the Researcher, MD2, Supervisor 1 and 2

The workshop participants identified four main environmental themes: solid waste, water use, energy consumption and transport of finished products to customers. In greater detail, these environmental themes involved the following:

- **Solid waste streams**: were divided into three distinct streams: landfill, recycling and animal feed. Waste sent to landfill largely was contaminated plastics; recycled waste included paper, wood crates and cardboard. Solid waste arising in food production was sent to animal feed. A particular measure identified with regards to waste streams was to improve the segregation of the different waste streams. The purpose of this was to reduce waste sent to landfill and find ways to recycle such waste. This was seen important because waste sent to landfill was a particular issue articulated by the UK Food and Drink Federation. The ambition was to eliminate waste to landfill.

- **Water use: concerns about water use were twofold:** (1) Water treatment capacity, and (2) the potential future risk limiting Firm growth. The concern over water treatment capacity included a particular focus on the infrastructure (e.g. pipes and pumps), and specific water use (e.g. hygiene, peelers, temperature control) to reduce pressure on the water treatment plant. Secondly, MD2 raised concern of water use in light of future growth. In his view, it is better if the Firm could focus its investment on production, rather than continuing investing in end-of-pipe measures.

- **Energy consumption**: workshop participants identified the main electricity uses to be refrigeration in raw material storage, the water treatment plant, the vacuum system for removal of solid waste from a particular production line, and compressors that produce air used in production. Additionally, workshop participants identified specific behaviours that could usefully be changed in order to reduce energy use. These included measures identified in production: temperature control to make sure the appropriate temperature is used in each room and the number of production hours; and in the offices this included switching off computers and lights at the end of the day.

- **Transport**: The Firm has a transport fleet that deliver finished products to customers. The issues identified in terms of transport were planning delivery routes, to utilise vehicles fully, and fuel type.

The environmental themes were identified and mapped out, as described above, in terms of activities 'causing' environmental impacts. Subsequently, the workshop participants identified relevant objectives in light of each environmental theme: reduce waste, send zero waste to landfill, and improve the efficiency regarding water, energy and transport. This also made it possible to identify and understand relevant performances indicators:

- Solid waste was measured in kilogrammes per month,
- Water was measured in cubic-metres per finished product,
- Energy was measured in kWh per finished product and
- Transport was measured in lorry miles per finished product.

The rationale to measure environmental performances in light of finished product was (1) to provide a link between environmental performances and production, and (2) focus on cleaner production measures. However, the waste streams were not identified in relation to production as the priority was to eliminate landfill waste. The environmental themes, critical objectives and performance indicators were summarised in a framework, as detailed in Figure 5.4 below.

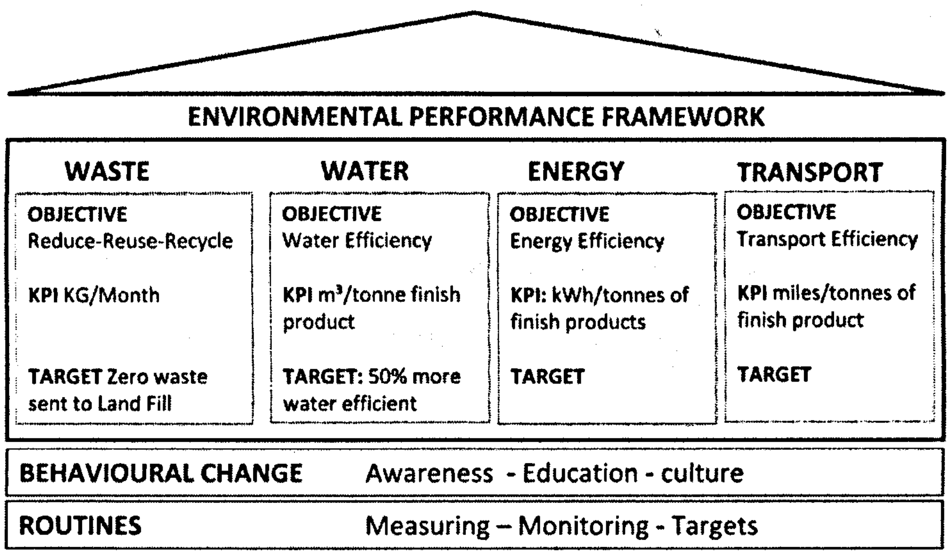

Figure 5-4: A visual representation of the outcome from the Environmental Management Workshop in the Firm (Adopted from the Firm)

The environmental performance framework detailed above was the main outcome from the workshop. Subsequently, it was argued by Factory Manager, Researcher and Environment Officer that it was necessary to engage participants in Firm capable of addressing objectives and meet the identified targets. For this purpose, behavioural change in terms of training and awareness was identified as an additional measure.

However, the framework identified in the workshop was abandoned because, soon afterwards, another framework focusing on sustainability was identified at the Parent Group level. This is documented in the next section

5.2.16 August 2010: Sustainability strategy identified at Parent Group

Separate from the work in the Firm, the Parent Group identified a business rationale built on the concept of sustainability. This built on the view that future access and availability of resources (energy, water and raw material) used in the Group divisions can impose a risk to business continuity in the longer term. It was argued by the Parent Group that costs of factor input (energy, water and raw material) are likely to change and will become more expensive and affect profitability.

It was therefore seen necessary to identify and pursue cleaner production measures in all Group divisions. The Parent Group needed a strategy to realise this. It should be noted that this was a more strategic approach (cf. section 5.2.17) than was at this time considered at the level of the Firm. A summary of the environmental problem and solution constructed in this situation is provided in table 5.22.

Table 5-22: August 2010

Environmental Problem	**Environmental Solution**	**Motivation**	**Main participants**
Access, cost and availability of natural resources in the longer term: raw materials, energy and water	Group Sustainability Champion enrolled by Parent Group; Development of Sustainability Strategy	Business continuity, maintain profitability	Parent Group, Group Sustainability Champion, Environmental committee, Environmental officer

The strategy identified by Parent Group was built on a well known framework integrating economic, social and environmental aspects of sustainability. This framework had been adopted in part of the food industry sector, by Marks and Spencer (M&S) in particular. The Parent Group appointed a Group Sustainability Champion (GSC) to develop a Sustainability Framework to be implemented in each of the Parent Group's divisions. The GSC had before this role worked as Sales Director in the Firm and as Commercial Director of another subsidiary of the Parent Group. Based on this knowledge and experience, the

Parent Group appointed him to this role. Hence, the Parent Group identified the concept of sustainability, depicted in Figure 5.5 below, to be important to pursue as part of the overall strategy for each division.

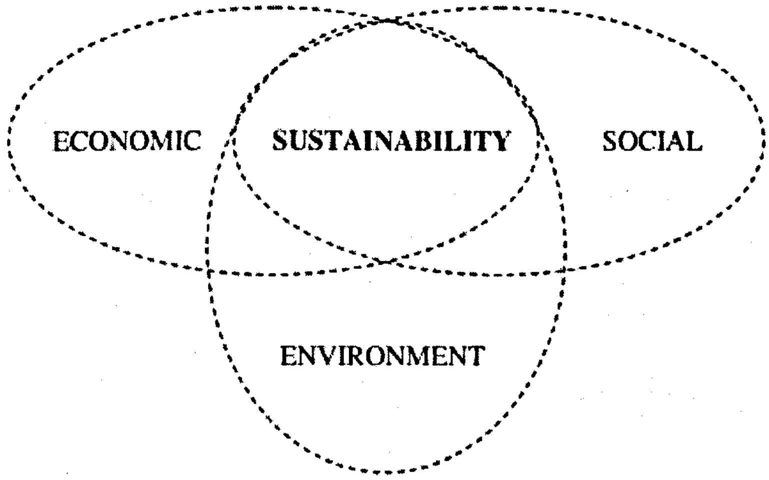

Figure 5-5: Sustainability model identified by Parent Group, accounting for economic, social and environmental aspect of sustainability (Adopted from the Firm)

The motivation behind this framework, according to the GSC, was increasing regulatory pressure regarding solid waste removal and water use, and emerging challenges associated with resource availability, e.g. energy and raw materials, which will affect the food industry in the longer term. The intention was to develop a Sustainability Strategy to address these concerns. The Sustainability Champion engaged participants from the Group's environmental committee (cf. section 4.3.2) to develop and implement this Sustainability Strategy. The main participants in the Firm enrolled to take part in the development of this strategy were the Environment Officer, the Factory Manager (FM2) and the Researcher. The development and implementation of this strategy is detailed subsequently.

5.2.17 September 2010 – October 2011: the development and implementation of the Sustainability Strategy

The development of the Group Sustainability Strategy, led by GSC, was viewed as a long term project to ensure business continuity. The GSC enrolled the Environment Officer and other representatives from each subsidiary of the Parent Group to participate in the development of this strategy. The purpose of inviting participants from each subsidiary was to engage them in the start of this project and to facilitate implementation of the Sustainability Strategy throughout the Group's subsidiary.

The Group's Sustainability Strategy was inspired by, among other things, the sustainability strategies developed by other organizations in the UK food industry such as Food and Drink Federation (FDF) and Marks and Spencer (M&S). First, the voluntary agreement developed by the FDF, and described in section 4.3.2, focused on energy consumption, water use, solid waste streams and transport activities. The FDF had, in the recent months, identified substantial changes in their environmental commitment with respect to the overall targets. For example, the existing commitment to reduce carbon emission was found to be outdated by the FDF and needed higher ambition to comply with the ambitions identified in other sectors of society. This change in the voluntary agreement and identified ambition affected development of the Group Sustainability Strategy.

Secondly, work undertaken by M&S and their 'Plan A[23]' involved a template that was found useful to structure the Group Sustainability Strategy. This Plan A template consists of key sustainability pillars, (e.g. climate change, waste, natural resources, fair partnership, health and wellbeing) and identified objectives that was meaningful to M&S. The Plan A

[23] M&S Plan A: The sustainability strategy developed by M&S. For more details, please visit http://plana.marksandspencer.com/

was identified by GSC as the most successful sustainability strategy in the UK food industry as it was established in 2007 and survived. Hence, the rationale to adopt this template from M&S was essentially twofold: (1) M&S is one of the Firm's major customers, and (2) the sustainability pillars in Plan A accords with the Firm's ambition to improve, among other things, resource productivity.

Work undertaken by the GSC in collaboration with participants from each Group subsidiary involved monthly meetings and interactions with key organizations such as the Food and Drink Federation (FDF). One of the key developments in this project comprised a framework of five sustainability pillars, which reflected particular aspirations. These pillars were constructed as follows:

- Social responsibility: health and wellbeing of employees and other stakeholders
- Raw materials: vegetables and packaging material
- Natural Resources: energy consumption and water use
- Transport: of vegetables in the supply chain
- Waste streams and disposal: reduce and recycle of waste streams of solid waste and effluent water

The above Sustainability Strategy developed at Parent Group can be viewed as a prescription device to provide guidance to each subsidiary of the Parent Group to identify and pursue cleaner production measures. The intention was for each subsidiary, such as the Firm, to undertake a local interpretation of the Sustainability Strategy. In this way, the Sustainability Strategy developed alongside existing operations in the Firm and aimed to stimulate local action.

The Environment Officer in Firm was enrolled by GSC to identify and prioritise a plan for action in light of these five pillars. The key participants responsible for the implementation of this strategy in the Firm were the FM2 and the Environmental Officer. The Researcher participated in this project to identify cleaner production measures.

The Sustainability Strategy identified a need to include all functions in the Firm. People in appropriate existing roles were enrolled as sustainability champions as part of their responsibility in the Firm, as described in bullet points below.

- Human Resource Manager became responsible for community engagement
- Engineering Manager became responsible efficient use of resources
- Planning Manager became responsible for transport efficiency
- Environment Officer became responsible for waste minimisation
- Procurement Manager became responsible for selection and use of raw materials

The key participants, as described above, were identified by The Factory Manager 2 and Environment Officer. The purpose was to identify and prioritise cleaner production measures in light of the Sustainability Strategy.

The Factory Manager and the Environment Officer identified short term action plans together with each the sustainability champions in the Firm. This action plan was structured in a framework including the following components: Pillar, Commitment, Initiative, Driver, Objective, Action required, Financial target, Sustainability target, Deadline, Sustainability Champion, Progress, and how identified actions link to the FDF voluntary agreement. For example, a particular project initiated in the Firm focused on replacement of compressor units. Details of this project are provided in Table 5.23 below.

Table 5-23: An example of action plan developed in the Firm in light of the Sustainability Strategy (Adopted from the Firm and modified by the Researcher)

Sustainability Framework in the Firm	**Application**
Sustainability Pillar	Efficient use of resources
Commitment	Carbon Reduction
Initiative	Replacement of compressors units
Driver	Cost Reduction
Objective	Reduce energy consumption and CO2 emissions
Action Required	Acquire new compressor unit
Financial target	Unknown
Sustainability target	Achieve 35% CO2 reduction by 2020
Deadline	October 2011
Sustainability Champion	Engineering Manager
Link to FDF	Cutting CO2 emissions

The idea to invest in new compressors was identified by Project Engineering Manager, as described in section 4.4.2. However, this investment was not prioritised at that time. In contrast, the Sustainability Framework supported cleaner production measures that had struggled in the past, including installing new compressors. The work on the Group-level Sustainability Framework led by GSC also identified projects that were not suitable to be undertaken in the Firm or other divisions alone. For example, the GSC engaged in a project undertaken in collaboration with participants from other companies in relation to the FDF to identify an approach to undertaker carbon foot printing in the food sector.

At this point, the Researcher was engaged in a strategic project focused on the Firm's water use in the longer term.

5.2.18 December 2010: Strategic approach to address water in the Firm

The Researcher's role and relationship with the Firm changed at this time. The Researcher was no longer positioned inside the Firm as a participant observer. Instead, a position as outsider 'looking-in' emerged. The development and implementation of the Sustainability Strategy in the Firm identified a need to address the firm's water use in the longer term. Moreover, this Sustainability Strategy identified a need to address water used by the Firm's suppliers that are growing vegetables.

The underlying rationale was essentially twofold. First, changes in the Firm's abstraction license, described in section 5.2.16, could force the Firm to reduce water use in production or abstract water in a different way. Second, there was an awareness concerning water used by the firm's suppliers in areas where access to water could be constrained and therefore hinder growing and supply of vegetables.

The Researcher was invited to participate in a project focused on potential future issues of water use. The identified issues are detailed in bullet points below with respect to water use in the Firm and water used by the Firm's suppliers subsequently.

Water use in the Firm concerned the following aspects:

- Future changes in regulation with respect to water (e.g. abstraction licence)
- Future changes in water regulation scheme with respect to water license trading

- Future change in water demand in the region where the Firm operates
- Future changes in the cost of water

The concern over water use in the Firm involved a particular focus on potential future shifts in the regulation of water abstraction licenses and discharge licenses. For example, it was anticipated that a trading scheme for water abstraction licenses would emerge in England. Additionally, water shortages were identified as a potential threat to UK food sectors in some regions, particularly during the summer months. The water used by the UK based growers is therefore a concern to the Firm's choice of suppliers from which vegetables are sourced during the summers. Moreover, vegetables are sourced from countries outside the UK during the winter in particular. Concerns about water used by growers in the UK and overseas are detailed below:

- Knowledge about water stress in areas from which the Firm source raw materials
- Knowledge about water regulation in countries where raw materials are sourced
- Knowledge about competition around water in countries where raw materials are sourced
- Knowledge about alternative procurement away from areas where water security is at risk

The availability of water to companies that supply raw materials to the firm was identified as an important issue. The GSC identified a potential threat of future water shortages in parts of the world from which the Firm sourced its vegetables. In this regard, critical factors that could affect the Firm's procurement strategy of raw materials outside UK included potential changes in water related regulations, conflicts and increased competition among water users. Although these were not pressing concerns for the Firm in the short run, the effect of these on the future viability of the Firm in the long run was recognised. A procurement strategy was sought to address these concerns. A summary of the environmental problem and solution constructed in this situation is provided in table 5.24.

Table 5-24: December 2010 to October 2011

Environmental problem	**Environmental solution**	**Motivation**	**Main participants**
Future access and availability to water used by the Firm; Access and Availability to water among the Firm's suppliers	Develop a strategy to address water in the Firm; incorporate water as criteria in the Firm procurement strategy of raw materials	Business continuity	Group Sustainability Champion, the Researcher, Supervisor 1 and 2, the Environment Officer

Having presented a reflective narrative of an environmental innovation journey observed in the Firm using ethnographic methods, the following section provides a summary and critical reflection.

5.3 Summary and critical reflection

The following section provides a summary and critical reflection of the temporally ordered narrative presented above. The summary identifies the key findings from this reflective account of an environmental innovation journey, conceptualised as a social process, involving the construction of environmental problems and solutions. The critical reflection identifies and discusses the limitations of accounting for the environmental innovation journey in this way. This chapter concludes with a proposition to make sense of the environmental innovation journey conceptualised as social practices.

5.3.1 Summary of the findings from the temporally ordered narrative

The above narrative presented a temporally ordered account of the environmental innovation journey conceptualised as social process involving the construction of environmental problems and solutions. The narrative consist of data collected in the Firm situated in the UK food and farming sector using ethnographic methods such as participant observation and semi-structured interview. A research perspective, and not a theory, was established in the approach to this study as detailed in section 2.4.5.

This perspective followed constructivist commentators in social sciences (cf. Guy and Shove, 2000; Guy and Moore, 2005; and Beveridge and Guy, 2005) and highlighted the need to explore how an environmental innovation journey, conceptualised as a social process actually unfolds. An interpretive framework developed from literature to study the environmental innovation journey, conceptualised as social process, involving the construction of environmental problems and solutions.

Analytical categories were identified in literature and used as a template (cf. sections 3.3.1 and 5.1.1). This interpretive framework identified the following analytical categories:

- situations with reference to time and place;
- the social construction of environmental problems; environmental solutions, and
- the key participants and their motivations.

A summary of the situations in which environmental problems and solutions were found constructed in the Firm as observed by the researcher over time is provided in tables 5.25, 5.26, 5.27 and 5.28. Findings from exploring the environmental innovation journey are summarised in four tables. Each table represent a time period that proceed to a shift in direction of the journey.

Table 5.25 identifies the work on the Environmental Strategy to achieve superior environmental performance in the Firm. This included a number of strategic project led by the Group Advisor and MD1 in collaboration with other participants. However, the strategic projects were not implemented because these were hard to justify and manage. A key observation during this time period was the lean manufacturing project led by the Operational Director. Work to implement a lean manufacturing framework in the factory focused on production throughput and did not include other aspects such as water use or energy consumption. Work to reduce energy consumption and water use was undertaken by the engineering department.

Table 5-25: Summary of situations in which environmental problems and solutions was constructed in Firm October 2008 – March 2009

Situations	Environmental problems	Environmental solutions	Motivations	Main participants
October 2008 To February 2009	Solid waste removal and disposal	Up-flow-anaerobic-sludge-blanket-reactor (UASB)	Make waste valuable rather than paying for disposal	Group Advisor, Project Engineer Manager, Environment Officer, the Researcher, a consultant
November 2008	Electricity consumption	Refrigeration use in production	Reduce electricity cost in production	Project Engineer Manager, H&S Manager, Raw Material Manager, Technical staff, the Researcher, consultant from Carbon Trust
December 2008 to January 2009	Water use and treatment	Upgrade Water treatment plant; Water Recycle via MBR technology	Water availability and treatment	Group Advisor, Engineers, Consultant, Researcher, technology providers
February 2009	Water use in production	Identify the Firm's water balance	Reduce water use in production, reduce pressure on the water treatment	The Engineer, the Researcher, the Project Engineer Manager, the FDF
March to April 2009	Lean Manufacturing Framework failed. New actors (FM1, interim operational director, Engineer Manager and Production Manager) appointed in leading positions. A new Factory Management Framework, labelled daily reviews, were developed and implemented by FM1 together with managers in the Firm			

The lean manufacturing project was taken over by a new interim operational director and Factory Manager 1, who changed focus. Instead of an emphasis on production throughput, a broader set of key performance indicators was identified in a framework labelled daily reviews. The purpose of this new framework was to organise production in the factory in a better way. Following this shift in managerial attention in the Firm it was noted that work on strategic projects such as MBR was replaced by short term and incremental type of projects to improve, among other things, environmental performances. A summary of the events that followed this shift in the Firm is provided in Table 5.26.

Table 5-26: Summary of situations in which environmental problems and solutions was found constructed in Firm April 2009 – January 2010

Situations	Environmental Problems	Environmental solutions	Motivation	Main participants
March to April 2009	Water use in production	Integrate water use as performance required by Factory Management Framework	Reduce water use in production, which also help reduce the pressure on the water treatment	The Engineer, the Researcher, the Factory Manager 1, Production Staff
June to August 2009	Water treatment capacity with respect to time and volume	Quick technical fixes: upgrade water holding tank and improve performance of mechanical treatment	Secure water treatment performance required by production.	Project Engineer Manager, The Engineer, the Researcher, MD1, Contractor doing the ground work,
June to August 2009	Water use in Production	Establish Water Group with specific remit to address water use in production	Reduce water use, reduce pressure on the water treatment plant	The researcher, the Engineering Manager, the Production Manager, the Hygiene Manager, MSc student, MD1 and the Steering Group
June to August 2009	Water use in production	Water use performance required in production; different way to clean factory floor	Reduce water use in production, reduce pressure on water treatment plant	The Engineer, the Researcher, Production Manager, MSc Student, Hygiene Manager, MD1 and Steering Group
June to	Water use in	Inform	Reduce water	The Engineer, the

August 2009	production	production staff about water use and create awareness why water use needs reducing	use in production, reduce pressure on water treatment plant	Researcher, Production Manager, MSc Student, Hygiene Manager, MD1 and Steering Group
September 2009	Natural resource use in the Firm: raw materials, energy and water	Establish a strategy that focus on greener and leaner:	Reduce cost of factor inputs: raw material, water and energy	MD1, FM1, the Researcher, Supervisor 1, Sales Director
October 2009	Water use in production	Informing production staff via posters and guided tours to change water use behaviour in production	Reduce water use in production, reduce pressure on water treatment plant	The Engineer, the Researcher, Production Manager, Hygiene Manager, production staff, Marketing consultant
November 2009	Production throughput	Identify and implement measures in production as to improve production throughputs	Cost of vegetable input and profitability	FM1, MD1, the Engineer Manager, Production Manager, Procurement Manager, Technical Manager, Raw Material Manger, sales manager and Warehouse Manager
December 2009 – January 2010	Work on the Environmental Strategy was put on hold; other priorities deflected implementation of this strategy in the Firm. Concerns about production throughput attracted managerial attention at this time. A shift in leadership emerged in January 2010.			

Table 5.26, above, provides a summary of events up to the appointment of an interim managing director (MD2). Work on the Environmental Strategy was put on hold as the key champion, MD1, left the Firm. MD2 had experience in working as an Operational Director and was therefore selected to improve production throughput in the Firm. This shift in

leadership changed direction of the environmental innovation journey. MD1 was found to be more oriented in commercial projects such as the Environmental Strategy. MD2, on the other hand, was found to focus more on operations in the factory. MD2 appointed a new factory manager (FM2). FM2 developed a new way of organising operations in the factory and appointed the Water Engineer as Environment Officer. Work to achieve superior environmental performances in the Firm was led by the Environment Officer and FM2. A summary of the events observed during this time period is provided in Table 5.27.

Table 5-27: Summary of situations in which environmental problems and solutions were found constructed in Firm February 2010 – July 2010

Situations	**Environmental Problems**	**Environmental Solutions**	**Motivations**	**Main participants**
March to May 2010	Natural resource use in the Firm: raw materials, energy and water	Environmental Officer enrolled to develop Environmental Performance Framework	Reduce cost of factor input; ensure compliance with environmental regulation and FDF voluntary agreement	The Environmental Officer, FM2, the Researcher, MD2, FDF, the EA
March to May 2010	Natural resource use in the Firm: raw materials, energy and water	Environmental Officer enrolled to develop Environmental Performance Framework	Reduce cost of factor input; ensure compliance with environmental regulation and FDF voluntary agreement	The Environmental Officer, FM2, the Researcher, MD2, FDF, the EA
March to May 2010	Water use in production	Separate infrastructure for water supplied to cleaners; water recirculation device on a food	Reduce cost of water use and reduce pressure on water treatment plant	The Environmental Officer, FM2, Hygiene Manager, food processing machine company

		processing machine		
June 2010	Resource use in the Firm: raw materials, water and energy	Integrate environmental performances required into the overall Factory Framework; undertake workshop to inform managers about environmental performances required	Engage Managers in the Firm with environmental performances required, Reduce cost of factor input; ensure compliance with environmental regulation and FDF voluntary agreement	The Environmental Officer, FM2, the Researcher, MD2, Supervisor 1 and 2, Managers in the Firm, FDF, EA
July 2010	Sustainability Strategy identified at Parent Group, led by Sustainability Champion. Leadership shift in Firm, Managing Director 3 appointed.			

A number of projects to improve environmental performances in the Firm developed as noted in Table 5.27 above. These projects were developed and implemented by the Environment Officer and FM2 in collaboration with other participants in the Firm. A distinct project was initiated by FM2, the Research and the Environment Officer to integrate work on environmental performances with the overall operational management framework in the Firm. However, this project was brought to a halt as work to develop a new Sustainability Strategy was identified at the Parent Group. This project was led by the Group Sustainability Champion. A summary of the events observed during this time period is provided in table 5.28.

Table 5-28: Summary of situation in which environmental problems and solutions were found constructed in Firm August 2010 – October 2011

Situations	Environmental Problems	Environmental Innovations	Motivations	Main participants
August 2010	Access, cost and availability of natural resources in the future: raw materials, energy and water	Group Sustainability Champion enrolled by PG; Development of Sustainability Strategy	Business continuity, maintain profitability	Parent Group, Group Sustainability Champion, Environmental committee, Environmental officer
September 2010	Researcher's position changed to outsider looking in			
October 2010 To October 2011	Future access and availability to water used by the Firm; Access and Availability to water among the Firm's suppliers	Develop a strategy to address water in the Firm; incorporate water as criteria in the Firm procurement strategy of raw materials	Business continuity	Group Sustainability Champion, the Researcher, Supervisor 1 and 2, the Environment Officer

Work on the Sustainability Strategy changed the nature and direction of the environmental innovation journey. This reflective narrative generated a number of insights. First, how environmental problems and solutions are socially constructed and proceed over time (see 5.3.1.1). Second, technologies were found to affect the social construction of environmental problems and solutions (see 5.3.1.2). Third, the environmental innovation journey was found to be an ongoing process that proceeds in a non-linear fashion involving temporary fixes that are reversible (see 5.3.1.3). The environmental innovation journey is characterised as a multiple, contingent and fluid process. Drawing on the reflective account of the environmental innovation journey, these insights are subsequently unpacked.

5.3.1.1 How environmental problems and solutions are socially constructed

This reflective narrative shows that participants involved in this process did not identify solutions to environmental problems as a result of changes in the natural environment. This insight accords with Castree (2005) and Hajer (1995) who argues that the natural environment cannot be fully known. Environmental problems and solutions were rather found selected by participants in response to social constructs such as texts. For example, concerns about water use in the Firm were affected by many participants and social constructs.

The social constructs that affected problems and solutions around water use were multiple. Among other things, the Water Engineer in the Firm recorded the Firm's water use and shared this information with other participants. Information about water use was presented in figures, e.g. X cubic meters used per day, and sometimes as graph showing a trend in water use over time, e.g. a year. Participants in the Firm made sense of problems around water use by using this information.

A second social construct that was found to affect environmental problems and solutions around water use was the water abstraction license and water discharge license that consist of text provided by the EA. These licenses informed participants in the Firm about performances required around water use. A third social construct was the Environmental Strategy developed by MD1 in collaboration with other participants in the Firm that sought to enhance resource productivity with respect to water use.

Solutions to environmental problems were found posited by participants in the Firm. However, environmental problems did not always come before the solution to a problem was identified. For example, the Environmental Strategy identified by MD1 (cf. Section 4.4) focused on resource productivity in the Firm's operations such as vegetable throughput and water use. However this strategy did not emerge as a result of environmental problems identified because of changes in the natural environment. The Environmental Strategy rather identified that the cost of natural resources used in the Firm is necessary to capture. The underlying rationale was to reduce cost of factor inputs, e.g. vegetables, energy and water, in the Firm's operations. This insight shows that the Environmental Strategy is a solution to environmental problems in the Firm. However, the strategic framework did not identify problems first, these emerged subsequently. Hence, solution preceded problems. The strategic framework guided participants in the Firm to identify environmental problems.

The Environmental Strategy was therefore found built around the participants (e.g. MD1) and their images of performances required of the Firm in this sector. Following van Dijk (2011) images refer to the people in the Firm and how they conceive existing and future performances required. For example, MD1 argued that the Firm needed to grow as a business and attract customers through its superior environmental performances and reduced cost of factor inputs. In other words, in light of this vision existing performances in the Firm needed to be changed. Hence, this vision identified a discrepancy between existing performances and future performances required. The Firm's customers were found to be key actors and affected this vision and associated Environmental Strategy including the environmental problems and solutions constructed in the Firm.

This insight identified actors, e.g. customers, beyond the traditional nexus of a firm, as participants of the environmental innovation journey (see Appendix C for information about specific organisations and participants accounted for in this case study). Moreover, this study did not only account for human participants, but also technologies were found to affect the social construction of environmental problems and solutions. For example, the water treatment plant attracted attention among participants to resolve water treatment capacity. The following section provides details about technologies identified in accounting for the environmental innovation journey.

5.3.1.2 Technologies affect the environmental innovation journey

This reflective narrative, presented above, included many technologies found in the Firm contributing to the social construction of environmental problems and solutions. For example, section 5.2.4 reflects on a situation in which the water treatment plant attracted attention among participants to resolve problems identified around water use. The Participants identified a solution to upgrade the existing water treatment plant with MBR technology. This situation did not only account for existing technology, but identified a technological device, e.g. MBR, to resolve the problem at hand. In making a decision about MBR the Group Advisor enrolled a financial investment appraisal method that is typical in calculating the costs and benefits of a decision.

Many different technologies were thus found contributing to the nature and direction of the environmental innovation journey. These technologies are here divided into the following categories: artefacts and frameworks, infrastructures and devices. Artefacts and frameworks are here treated as things made in the Firm or outside the Firm to make sense of something such as a strategic framework or regulation. Infrastructure is here treated as buildings, e.g. the factory, and the complexes of water pipes and water pumps making up the system of supply of water to the Firm. Devices are here treated as things enrolled in the

Firm to complete performances such as food processing. An example of a device is therefore a food processing machine.

A summary of technologies accounted for in this study of an environmental innovation journey is provided in table 5.29. See also Appendix C for further details.

Table 5-29: Summary of the main technologies accounted for in the environmental innovation journey (own development)

Technology categories	Technologies accounted for in the Firm
Artefacts and frameworks	The Environmental Strategy; The Firm's Brand; The Sustainability Strategy, The M&S Plan A; The FDF Voluntary Agreement; Regulatory frameworks, e.g. Climate Change Levy, water abstraction and discharge licenses; water balance framework; Water use graphs; Factory Management Framework; Operational Framework; the Environmental Reporting Framework
Infrastructure	The factory; refrigeration units and warehouse; Water treatment plant; water system including water- borehole, pumps and pipes; Infrastructure for solid waste streams and disposal
Devices	Membrane Bio-Reactor; Anaerobic Digestion; water meters; investment appraisal; food processing machines; NOBO board; the water recycling unit; the hygiene water unit

This section has drawn the attention to the technologies accounted for in this study as detailed in table 5.29 above. However, technologies were not found to have agency as to influence the construction of environmental problems and solutions. This insight rather shows that participants in the Firm do things in conjunction with technologies. For example, the Water Engineer produces information about water use in the Firm in conjunction with water meters (cf. 5.2.3). Participants in the Firm enrol technologies to complete performances required such as food processing machines to produce pre-cut vegetables. Moreover, participants enrol technologies to resolve environmental problems. For example, a water balance tank was enrolled to upgrade water treatment capacity.

Technologies were thus found contributing to the nature and direction of the environmental innovation journey and are therefore necessary to account for when making sense of this process. The following section identifies the main characteristics of the environmental innovation journey as one involving both participants and technologies.

5.3.1.3 The main characteristics of the environmental innovation journey

The environmental innovation journey, accounted for in this study, was found to be an ongoing process that proceeds in a non-linear fashion involving temporary fixes that are reversible. Ongoing refers to the insight that environmental innovation has no distinct beginnings or ends. Non-linear refers to the idea that environmental problems and solutions are constructed and proceed in a non-linear process that does not proceed progressively from plan to implementation and completion of environmental innovation.

The environmental innovation journey was rather found to consist of temporary fixes: a solution that works for some time and is incrementally adjusted by participants as necessary. For example, the water treatment plant is a technology that works in conjunction with participants, e.g. the Water Engineer, in the Firm to sanitise water used in the factory. This solution works continuously and was found to change incrementally over time. For example, participants in the Firm, e.g. the Project Engineer Manager, enrolled a water balance tank to increase water treatment capacity as described in section 5.2.7. In other words, the Firm showed a strong preference for incremental changes that are realised in the short term as opposed to implementing strategic projects. The strategic projects were hard to justify or manage.

Environmental innovation can also be unmade and is therefore reversible. For example, the Environmental Strategy was a new development in the Firm and guided participants to focus on resource productivity. However, this strategic framework focusing on solutions to enhance resource productivity in the longer term was challenged by participants, e.g. FM1 and Procurement Director, who prioritised work in the short term such as production throughput in particular.

In accounting for this process, the following key characteristics were identified: the environmental innovation journey is multiple, contingent and fluid. Each of these characteristics is unpacked subsequently.

First, multiplicity refers to the insight that the environmental innovation journey consists of many trajectories available to the Firm. A trajectory is a concerted effort found in the Firm to create something to resolve environmental problems. This study identified multiple trajectories shaped by many participants and affected by many technologies. Participants that were found contributing to the construction of environmental problems and solutions are not limited to the Firm. This study identified participants beyond the traditional firm-nexus such as managers and staff, and accounted for participants external to the Firm such as consultants, regulators, customers and suppliers. These participants made physical appearances in the Firm. Moreover, technologies, e.g. strategies and frameworks, developed by organisations outside the Firm such as the FDF Voluntary Agreement affected the environmental innovation journey inside the Firm. The participants and technologies contributing to the environmental innovation journey and the construction of environmental problems and solutions was found to be multiple and diverse and shifted across time and space.

Second, the environmental innovation journey was found to be contingent upon many participants and their imaginings of possible futures. Here, future is plural and not just one. This insight accords with Guy and Shove (2000), and Guy and Farmer (2001) and the idea that the focus on a distinct unilinear trajectory should be replaced with acknowledging 'multiple design routes' to sustainable futures. This is important because the nature and direction of the environmental innovation journey found in the Firm was found to be shaped by many participants and their imaginings of environmental problems identified as necessary to resolve. However, participants were not always found to be sharing the same image of the future. For example, section 5.2.8 shows that the MD1 was trying to pursue the Environmental Strategy in the Firm, while other participants, e.g. Procurement Director, Marketing Consultant, and customers, were not supporting this image.

Third, the fluid nature of the environmental innovation journey refers to the idea that the development of novelties is ongoing and shaped by multiple and competing imaginings. Environmental innovation can therefore be described as temporary fixes that are reversible. The utility of providing a snapshot of an environmental innovation journey is therefore questionable. In accounting for the environmental innovation journey as a social process that unfolds over time, this study found that the context through which environmental innovation unfolds matter. Context should therefore not be relegated into the background.

This section has identified the main characteristics of the environmental innovation journey as:

- the development of novelty to achieve superior environmental performances unfolds through time and space;
- shaped by many participants through interaction and negotiation;
- affected by technologies, and
- consisting of multiple trajectories, contingent upon many participants and is fluid.

A critical reflection and the limitations of the research perspective established to account for the environmental innovation journey is provided subsequently.

5.3.1.4 Critical reflection on the role of the Researcher in this study

The Researcher engaged in the environmental innovation journey via ethnographic methods e.g. participant observation. This means that the Researcher was also a participant in this journey and is accounted for in this analysis. The role of the Researcher was therefore twofold. First, the Researcher was participating in the work undertaken by other people in the Firm with particular reference to environmental problems and solutions. Data were collected via interaction with other people in the Firm. Observations were typically made in meetings and daily events and reflected on the work undertaken by people in the Firm including the Researcher. The second role was that the Researcher reflected on what was going on in this firm in light of theories of environmental innovation.

At the beginning of this study the Researcher spent the majority of the time in the Firm. This was the time during which the Environmental Strategy was on the Firm's agenda. Time spent in the Firm during the period October 2008 to December 2009 was on average three to four days a week. The Researcher engaged in particular projects identified by other participants (e.g. MD1) in the Firm such as work to address issues of water use. Later, other priorities in the Firm made work on this Environmental Strategy unwarranted. The role of the Researcher changed following this event.

From January 2010 to April 2010 the Researcher spent less time in the Firm and more time at the University. Time spent in the Firm during this period was on average one day a week.

The relationship with the Firm was maintained while new participants engaged with the Firm (e.g. MD2 and FM2). Although less time was spent in the Firm during this period, the Researcher was still able to account for certain events in the Firm such as changes in people engaged with the Firm. A new project was initiated in the Firm focusing on environmental performances in light of operational practices in April 2010. The role of the Researcher changed following this event. Time spent in the Firm was now on average 2-3 times a week during the period April 2010 to October 2010.

The events leading to the Environmental Strategy being abandoned stimulated critical reflection. During January 2010 to April 2010 time was used to critically reflect on the environmental innovation journey conceptualised as a social process. This process identified key insights. More specifically, that environmental innovation process is non-linear, involving multiple social actors, is ongoing and reversible. This means that the environmental innovation journey is much more messy and complex than what realist 'clean' account suggest. These insights stimulated further research. The Researcher continued data collection in the Firm while reviewed alternative literature to account for environmental innovation.

5.3.2 Critical reflection and limitations of this research perspective

The insight generated from this ethnographic case study accords with constructivist commentators in social sciences (cf. Guy and Shove, 2000, Moss et al., 2005; and Bevergidge and Guy, 2005). The environmental innovation journey is much more messy and complex than realist stylised accounts suggest. In much of the literature, environmental innovation in general (cf. Foxon et al 2005) and the (environmental) innovation journey in particular (cf. Van de Ven et al., 1999; Rip and Shot, 2002) is thought of as a unilinear process that proceeds from plan to implementation.

Rip and Shot (2002) build on structuration theory (Giddens, 1984) and identify an account of the innovation journey. This account describes the emergence of novelty as a process that proceeds from the initial design of an innovation such as a new technological device. This device becomes embedded (or not) in society over time through wider diffusion into society in which the technological device becomes contextualised. The innovation journey, seen in this way, is irreversible. It is therefore argued to be important among policy makers and planners to get it right from the start by promoting 'individual' environmental innovation journeys in the right direction (Rip and Shot, 2002).

Environmental innovation studies rooted in social sciences have therefore paid particular attention to identify non-technical barriers to progress (Guy and Shove, 2000). These non-technical barriers include, among other things, a lack of knowledge among key actors, lack of incentives and sanctions. The literature on environmental innovation journeys emphasises linear narratives focusing on the interplay of individual motivation, e.g. firm strategy, and external contextual forces, e.g. market conditions and regulatory structure, and present this in stylised accounts. However, such stylised accounts overlook the actual processes that unfold in specific context (Guy, 2006). Actual processes inside firms are often replaced with preconceptions, e.g. rational choice and key actors, at the expense of considering the contribution of other relevant actors, actual behaviour and their context.

Following Law (2004) realist accounts of the environmental innovation journey are stylised and provide a snapshot of essential properties, e.g. individual motivations and contextual forces, which are found to be generic across time and space. Such accounts are therefore not geared to understand how such properties are made, and are limited to understand how an environmental innovation journey is made in specific contexts.

The insight generated from this ethnographic study identified an environmental innovation journey that is much more messy and complex than realist accounts suggests. Participants in the Firm did not take part in a journey as one that proceeds from plan through to implementation and termination. The processes observed in the Firm did not accord with the characteristics identified in literature (c.f. Van de Ven et al., 1999; Rip and Shot, 2002), which suggests that innovation journeys are (1) progressive and irreversible, and (2) that failure or success are determined by drivers and barriers.

In contrast, this study identified an environmental innovation journey as one that consists of multiple trajectories, contingent upon many participants and that is fluid as it unfolds through time and space. However, this insight is not without limitations. The focus on an environmental innovation journey conceptualised as a social process do not provide a meaningful or useful representation as to understand the environmental innovation journey. The utility of this simple conception is questionable as the search for environmental problems and solutions observed in this study never seemed to end (or until the research funding runs out). Moreover, it must be acknowledged that a firm and an environmental innovation journey unfolding in a firm cannot be known in its full complexity.

The insights generated from this study identified the limitations of realist stylised framework and accord with Beveridge and Guy, (2005) in that context matters. For example, a framework such as Environmental Management System (EMS) provided by ISO[24] does not fall evenly across time and space. An EMS guides participants to identify environmental aspects, impacts and solutions as to amend these. However, such frameworks do not say much about how environmental problems and solutions are constructed. For example, participants in the Firm were not found engaged in activities so as to systematically identify environmental aspects and impacts.

Following Law (2004) the danger with stylised frameworks is that they can rather make a mess trying to describe a phenomenon. However, this limitation of frameworks to make sense of the phenomenon studied does not mean that frameworks should be abandoned. Following Cilliers (2002) 'we need frameworks in order to say something'. Hence, frameworks should be applied to make sense without making a mess of describing the phenomenon studied (Law, 2004). This insight stimulated further research to develop representations and accounts that do not make a mess when accounting for environmental innovation.

In recent literature, Shove and Walker (2010) and Pantzar and Shove (2010) identify practice as the unit of analysis in accounting for (environmental) innovation. This practice

[24] International Organization for Standardization (available at: http://www.iso.org/iso/home.html)

theory follows Giddens (1984) and accounts for more than what people do. In broad terms, people do things in conjunction with technologies to produce performances. This simple conception accords with the observations made in the Firm and was found as a useful approach to make sense of the environmental innovation journey without making a mess describing the phenomenon studied. This practice view identified in literature to make sense of the environmental innovation journey changed the research perspective. This new research perspective is explored in the subsequent chapter.

6 Making Sense of the Environmental Innovation Journey conceptualised as social practices

Having, in chapter 5, provided a detailed temporal account of the environmental innovation journey in the Firm, this chapter draws on practice theory (cf. Giddens 1984) to make sense of this account. This chapter focuses on the environmental innovation journey conceptualised as social practices. This practice theory identifies practice as the unit of analysis, rather than focusing on individuals or socio-technical systems and has emerged in recent literature (cf. Shove and Walker, 2010; Pantzar and Shove, 2010) to account for innovation in social practices such as Nordic Walking (Pantzar and Shove, 2010), showering, and congestion charges (Shove and Walker, 2010).

This practice theory, described in chapter 2, was identified and applied in this study to make sense of an account of the environmental innovation journey as social practices found in the Firm. This chapter has the following structure:

6.1 Introduction	The introduction develops research objective 4 and identifies social practices as the unit of analysis to make sense of the environmental innovation journey. A short summary of the practice theory of innovation found in literature (cf. Section 2.3.3) informs the development of a new research perspective and interpretive framework. This interpretive framework consists of the following analytical concepts: (1) participants, (2) images of performances, and (3) technologies. Inspired by Shove and Walker (2010), social practice consist of participants working in conjunction with technologies to produce performances in relation to their imaginings of environmental problems and performances required to resolve these.
6.2 Making sense of the	Findings for exploring the environmental innovation journey conceptualised as social practices found in the Firm provide an

	environmental innovation journey	account organised around the following practice categories: (1) strategic practices, (2) estate management practices, (3) operational practices, and (4) sustainability practices. This chapter shows how social practices found in the Firm developed over time.
6.3	**Summary and critical reflection**	The summary identifies the key findings from making sense of the environmental innovation journey conceptualised as social practices. This analysis shows how environmental problems and solutions are constructed in social practices. The critical reflection identifies the limitations of making sense of the environmental innovation journey seen in this way. Practice theory of innovation does not account for how the imagines of performances are made. This insight stimulated further research and identified discourse analysis.

6.1 Introduction

Chapter 5 provided an account of the environmental innovation journey, gathering information on the social process involving the construction of environmental problems and solutions. The environmental innovation journey explored in the Firm using ethnographic methods was found to be much more messy and complex than literature in this line of research suggests (cf. Geels and Schot, 2010). Among other things, what goes on inside a firm is black boxed and replaced with pre-assumptions such as rational choice and the importance of key actors at the expense of considering the contribution of others.

In contrast, the findings in chapter 5 show that the environmental innovation journey is contingent upon many participants and their imaginings of possible futures. This account identified multiple participants, but also technologies, as having an effect on the social construction of environmental problems and solutions. For example, the Firm's Environmental Strategy identified resource productivity and guided participants to identify ways to achieve this, e.g. by reducing water use in production. Moreover, environmental innovation was not found to proceed from plan to implementation as suggested in unilinear models of innovation, but was rather found to be an ongoing process involving temporary fixes that are reversible.

Chapter 5 concluded that context matters to understanding an environmental innovation journey and should therefore not be suppressed into the background. This insight accords with constructivist commentators in social sciences (cf. Guy and Shove, 2000) in that realist stylised accounts lack contextual sensitivity. However, this does not mean that research cannot make sense of an environmental innovation journey. This chapter draws on practice theory and identifies practices as the unit of analysis to aid sense making.

This practice theory of innovation accords with the constructivist perspective adopted in this study: practice is a social process, but consists of more than what people do. In broad terms, people do things in conjunction with technologies to produce performances such as showering and Nordic walking (cf. Pantzar and Shove, 2010; Shove and Walker, 2010), and identifies innovation as changes in the elements (images, skills, and materials) of social practices.

This literature on practice theory identifies an alternative framework (to the unilinear model) to account for environmental innovation. This insight from literature identified research objective 4:

- **Research Objective 4**: To identify and critically reflect on the environmental innovation journey conceptualised as social practices

Research objective 4 represents a progressive move in the research funnel to make sense of the environmental innovation journey. An interpretive framework inspired by literature on practice theory was developed to account for the environmental innovation journey conceptualised social practices. Details about the interpretive framework developed to achieve this are provided subsequently.

6.1.1 Practice theory of innovation

Drawing on practice theory, such as Giddens, (1984), Reckwitz, (2002), Pantzar and Shove (2010) and Shove and Walker (2010), this section identifies how we can make sense of innovation conceptualised as social practices. Pantzar and Shove (2010) draw on the example of Nordic Walking to illustrate innovation in social practices. Although this example has little to do with what goes on inside a UK food processing firm, it illustrates the elements of theoretical analysis needed. In their analysis, Pantzar and Shove (2010) identify the elements of social practices as images, skills, and materials.

Images involve the meanings and motivations embraced by participants to undertake a practice. Images therefore affect how practices are produced. For example, Nordic Walking is found to involve an image of outdoor activity, which shapes how this practice is made (Pantzar and Shove, 2010). Skill is the second element and involves the common understanding about the performances required in a practice. For example, walking with two sticks is a skill required to produce a performance such as Nordic Walking. The third element is materials, which is important as the social practice of Nordic Walking is not possible without two sticks. Hence social practices are interwoven with objects such as infrastructures and tools (Schatzki, 2002; Ropke, 2009). In accounting for the elements of practice in this way, Shove and Walker (2010) suggest that a practice cannot be reduced to any of these three elements.

Pantzar and Shove (2010) identify three distinct processes to understand innovation in social practices. First, social practices can be made, in which the elements of practice are drawn together for the first time by participants in relation to their imaginings of performances required. Second, social practices can persist and change incrementally through adjustment of the elements involved. Third, social practices can be deleted if the links between the elements of a practice are broken. This practice theory identifies the participants as the prime movers that contribute to innovation in social practices.

This practice theory of innovation, described above, is rooted in a post-structural perspective in social sciences. In broad terms, this post-structural perspective suggests that structures in society do not exist out there to which a universal theory can be applied to understand reality (Law, 2004). In contrast, reality is made in time and space specific contexts. Studies rooted in social sciences can identify and apply a structure, an interpretive framework, to make sense of the reality of the phenomenon studied.

This study found practice theory of innovation to aid sense making. This practice theory of innovation has been applied in research to understand the role of consumers and user practices. However, few studies have applied this practice theory to make sense of an environmental innovation journey in a firm. An interpretive framework was therefore developed, inspired by literature on practice theory of innovation, to account for the environmental innovation journey conceptualised as social practices. This interpretive framework is described subsequently.

6.1.2 Interpretive framework

A firm is a site where many interlinked social practices are made and it produces performances such as manufacturing, procurement, sales, marketing and budgets. Social practices in such a firm are therefore multiple and involve many interlinked elements. Following advocates of this practice view of innovation (cf. Pantzar and Shove, 2010) the three central elements of social practices found in the Firm are (1) participants, (2) images of performances and (3) technologies. An ideal model of practice is provided in Figure 6.1.

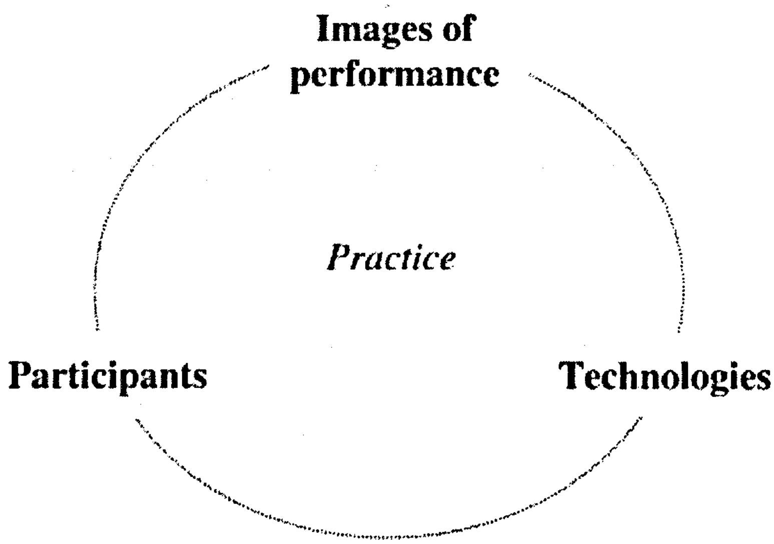

Figure 6-1: Ideal model of practice (own development based on Patnzar and Shove, 2010)

Participants are humans that are found to contribute to the development of social practices in the Firm. Participants therefore include staff and managers enrolled in the Firm as well as consultants, customers, suppliers and regulators that affect Firm practices.

Images of performances are meanings and motivations embraced by participants about present performances and required performances identified to resolve environmental problems. A discrepancy between present and required performances motivates change in Firm practices.

Technologies are those objects enrolled in Firm practices to produce performances.

These elements are analytical concepts found in literature and form the basis of the interpretive framework depicted in table 6.1.

Table 6-1: Interpretive framework to make sense of the environmental innovation journey conceptualised as social practices (own development inspired by Pantzar and Shove, 2010)

Elements of social practices	Description of analytical concepts
Participants	Participants are people that are found to be contributing to social practices in the Firm. A distinction is made between people that are seen as internal and external in relation to the Firm. People with employer contract with either the Firm or the Parent Group are treated as internal participants. People that affect social practices in the Firm without having an employer contract are treated as external participants
Images of performances	Images of performances are meanings and motivations embraced by participants about present and required performances (e.g. to resolve environmental problems)
Technologies	Technologies comprise those things enrolled in practices by participants to complete performances. Technologies are divided into three categories: artefacts (e.g. food processing machines), devices (e.g. management frameworks) and infrastructures

This framework was developed from literature to aid sense making and to develop a meaningful and useful representation of the phenomenon studied.

The environmental innovation journey conceptualised as social practices consists of participants that conceive and create new practices and change in existing ones in relation to their imaginings of environmental problems and performances required to resolve these. Participants are the prime movers in making practices. In accounting for this process, participants enrol other participants and technologies to produce performances required. Following Pantzar and Shove (2010) practices can undergo three changes.

First, new practices can be made in which participants draw elements (participants, images of performances and technologies) together for the first time to produce performances required. Second, participants redevelop practices over time by reproduced performances required. Third, performances that are no longer warranted are unmade: the relationships between the elements in the practice that produce unwarranted performances are broken.

Having described the interpretive framework inspired by practice theory of innovation, the following section explores the environmental innovation journey conceptualised as social practices found in the Firm.

6.2 Exploring the environmental innovation journey conceptualised as social practices found in the Firm

This chapter focuses on the account of an environmental innovation journey presented in chapter 5. In accounting for the environmental innovation journey conceptualised as social practices, judgements made by the researcher are required. This includes decisions of what counts as practices in the Firm. The researcher identified four categories of practices found in the Firm via ethnographic methods. These practice categories are:

- strategic,

- operational,
- estate management, and
- sustainability practices.

A short description of these social practice categories found in the Firm is provided in table 6.2.

Table 6-2: Practice categories and practices found in the Firm (own development)

Practice categories	Description	Distinct practices
Strategic practices	Participants working in conjunction with technologies enrolled to develop and implement the Environmental Strategy to improve environmental performances	New waste treatment practices, new cleaner production practices, new marketing practices
Operational practices	Participants working in conjunction with technologies to produce operational performances	Procurement, production and sales
Estate Management practices	Participants working in conjunction with technologies to produce maintenance and waste treatment performances	Maintenance practice and waste treatment practices
Sustainability practices	Participants working in conjunction with technologies to develop and implement the Sustainability Strategy	Development and implementation of the Sustainability Strategy

Having categorised social practices found in the Firm, as detailed in table 6.2 above, the environmental innovation journey, conceptualised as social practices, is presented in subsequent sections.

6.2.1 The development and implementation of the Environmental Strategy: October 2008 to January 2010

Managing Director (MD1) initiated and led development of the Firm's Environmental Strategy (cf. 4.4). The stated aim of this strategy was to enhance the Firm's competitive advantage by improving environmental performances in several areas: water use, energy consumption and solid waste generation. The rationale at work here was one seeking win-win solutions: improvements in environmental performance, which at the same time reduces the cost of factor inputs. It was argued by MD1 that an emphasis on environmental performances can attract existing and future customers to buy more products and thereby raise the Firm's marginal revenue.

The development and implementation of the Environmental Strategy in the Firm is here viewed as a social practice. Work on this strategy enrolled participants (e.g. the researcher and the Group Advisor) and technologies (e.g. strategic framework) to produce performances such as reducing cost of factor inputs and thereby improve profitability. This strategic framework is here viewed as an artefact enrolled to guide new developments in the Firm. The focus on new developments in this strategic practice shifted over time.

The following account of this strategic practice is therefore divided into three subsequent sections: (1) plans identified to address solid waste disposal and water treatment; (2) plans identified to develop cleaner production measures; (3) plans identified to disclose information about the Environmental Strategy to enhance the Firm's brand and image.

6.2.1.1 Waste stream practices: October 2008-March 2009

The strategy identified by MD1 in collaboration with other participants in the Firm anticipated future growth in production throughput and sales. However, an increase in production throughput was found constrained by existing arrangements of solid waste disposal and water treatment (cf. sections 5.2.1 and 5.2.4). This strategic practice identified a discrepancy between present and required performances with particular reference to end-of-pipe arrangements.

MD1 enrolled the Group Advisor with a specific remit to address this problem and identify a solution. A stated aim was to make solid waste streams that are unavoidable, (e.g. potato skins), more valuable to the Firm. A second aim was to identify a long term plan for water treatment in the Firm. The GA enrolled two consultants with specific remit to provide advice on solid waste disposal and water treatment respectively. In collaboration with consultants, the GA identified two distinct technologies, anaerobic digestion (AD) and Membrane Bio-Reactor (MBR).

As noted in chapter 5, the principal advantages of these two technologies were:

- They could increase end-of-pipe capacity of solid waste streams and water treatment as required by future increase in production throughput.
- They were found to enhance resource productivity in the long term. MBR can produce clean water that can be recycled back to the factory and thereby ease the abstraction of ground water. AD can transform unavoidable solid waste, e.g. potato skins, into biogas, which can be turned into electricity and subsequently supplied to the factory.

However, this investment appraisal in MBR and AD found the return on investment in these technologies to be low. AD was not found beneficial because the energy value of the solid waste stream was too low. The MBR was not seen beneficial because the return on investment was too long. A summary of this new strategic practice is provided in table 6.3.

Table 6-3: New waste stream practice conceived by participants

Situation	**Main participants**	**images of performance**	**Technologies**
October 2008 to March 2009	MD1, Group Advisor, Researcher, Supervisor 1; Consultants; Water Engineer, Finance Director	Enhanced end-of-pipe capacity required to meet the need for future production throughputs	Water treatment plant; MBR; AD; Investment appraisal; The Environmental Strategy

This strategic practice focusing on long term solutions to solid waste disposal and water treatment struggled and failed to be adopted. Instead, a number of short term actions were realised to increase water treatment capacity (cf. 5.2.7). Following the improvements to end-of-pipe capacity, new cleaner production practices developed. Thus practices developed incrementally, which seemed to fit better with the way the firm operated.

6.2.1.2 Cleaner production practices: April 2009 – January 2010

Work on the Environmental strategy, led by MD1, was rooted in a focus to achieve superior environmental performances in the longer term. The underlying rationale was to enhance resource productivity such as water use. Cleaner production is a concept that was suggested by the Researcher and Supervisor 1 to embrace resource productivity in the Firm. The reason at work here was that cleaner production measures have the advantage of addressing resource use at source and prevent increasing investment in end-of-pipe technologies.

A steering group was established, led by MD1, to identify and implement cleaner production practices in the Firm. MD1 enrolled FM1, Supervisor 1 and Technical Director to participate in this steering group (cf. section 5.2.7). Participants in this steering group identified a discrepancy between present water use and required water use to ease pressure on the water treatment plant. The Steering Group appointed the Water Engineer as champion with a specific remit to identify and implement cleaner production initiatives with respect to water use. The Water Engineer worked in collaboration with others and established a water group that included the Researcher, the Water Engineer, the Production Manager and the Hygiene Manager. This group met weekly to identify, implement and follow up actions to achieve superior water efficiency.

Water efficiency was a new performance identified in the Firm and is commonly described as water use compared to finished product. This performance was inspired by the voluntary commitment to improve environmental performance established by the Food and Drink Federation (cf. FDF in section 4.3.2). The Water Group identified and implemented a number of initiatives to improve water efficiency in the Firm. There was initially a particular focus on behavioural change in production. A key development was to make water use a key performance required in production (cf. Section 5.2.6) The FM1 made water use a key requirement in the factory management framework entitled Daily Reviews. The Water Engineer was enrolled to provide information about daily water use to the daily production meetings.

Secondly, the Water Group identified quick fixes to reduce water use in production such as implementing squeegees and shovels, which replaced water hose-pipe to clean the floors in the factory during production. Another quick-fix identified by the Water Engineer was to reduce the water pressure in the water supplied to the food processing machines. However, these measures were not found to engage with production staff. It was therefore suggested by the Researcher that training with respect to water use was required.

The Water Group developed guided tours: a concept to inform production staff about water use in the Firm beyond production (cf. Section 5.2.9). This new practice was found to be a useful opportunity for participants in the Firm to achieve a better understanding about water use in the Firm, but the guided tours did not last long as other performances in production were prioritised. The Water Group, seen as a strategic practice, was unmade because the weekly meetings stopped. However, other practices such as the use squeegee and shovel in production to clean factory floor redeveloped over time. A summary of development of cleaner production practices are provided in table 6.4.

Table 6.4: Cleaner production practices

Situation	Main participants	Images of performances	Technologies
April 2009 January 2010	Insiders: MD1, FM1, Researcher, Supervisor 1, Production Manager, the Water Engineer Outsiders: Marketing Consultant, FDF	Improve water efficiency to ease pressure on water treatment plant	Water use devices, e.g. water hose pipes, in production; FDF voluntary framework; Factory Management Framework of Daily Reviews, water treatment plant, The Environmental Strategy

In addition to the work carried out in light of the Environmental Strategy to produce cleaner production practices, MD1 identified new marketing practices to enhance the Firm's brand image. This new practice focused on ways to disclose information to customers and other key stakeholders about cleaner production practices developed in the Firm.

6.2.1.3 Marketing Practices January 2009 – September 2009

MD1 identified new marketing practices in the Firm to enhance the Firm's brand image and stimulate business growth (cf. Section 5.2.8). The motivation behind this new development, according to MD1, was that the present brand image did not accord with image of the Firm conceived by MD1. A key artefact in this marketing practice was the Environmental Strategy. The purpose of this strategy was to differentiate the Firm from its competitors with respect to environmental performances. It was therefore found necessary to disclose information about the Environmental Strategy.

MD1 enrolled the Marketing Consultant to develop new marketing practices in the Firm. One initiative was a new Firm website. This website disclosed information developed by participants in the Firm. Among other things, information about the Environmental Strategy was displayed including work to achieve superior environmental performances.

The Marketing Consultant also facilitated contacts between participants in the Firm, e.g. MD1, and food sector journals through which information about the Firm and the Environmental Strategy was disclosed. However, this marketing practice focusing on new developments such as the website and copies produced in food sector journals, was only prioritised for a limited time. Moreover, the focus on disclosure of information about the Environmental Strategy was challenged. The Marketing Consultant argued that customers in this sector were not interested in environmental performances. Instead, they advised MD1 to focus on the things that really mattered in this sector - the quality aspect of food production.

This focus on the quality aspect of production was shared by other participants in the Firm. For example, the Sales Director and Procurement Director argued that the Environmental Strategy was irrelevant at this time. Other performances required in the Firm such as production throughput needed prioritisation in the short term. Marketing practices involved new developments for the longer term and were therefore seen as less important. A summary of this marketing practice developed in the Firm is provided in table 6.4.

Table 6-4: New marketing practice

Situation	**Main participants**	**Images of Performances**	**Technologies**
June 2009- January 2010	Insiders: MD1, Researcher, Supervisor 1, Sales Director, Commercial Director Outsiders: Marketing Consultant, customers	Brand image with reference to environmental performances	Website and other forms of marketing channels, the Environmental Strategy; Firm's brand

The marketing practice developed in the Firm to disclose information about superior environmental performances struggled because the performance identified was found unwarranted. Other participants in the Firm, e.g. the Sales Director, the Procurement Director, and the Marketing Consultant, focused on other priorities such as production throughput in the short term. The marketing practices were unmade as the elements holding this practice together were broken. The MD1 left the Firm in January 2009 and the Environmental Strategy was no longer a priority in the Firm.

6.2.1.4 Summary of strategic practices developed to implement the Environmental Strategy

Work on the Environmental Strategy was led by MD1 and developed in collaboration with other participants in the Firm. This strategy identified resource productivity to achieve a competitive advantage in the longer term. Three distinct developments conceived by participants in the Firm accounted for:

- new waste treatment practices;
- cleaner production practices, and
- marketing practices.

The underlying rationale in these practices was images of performances required to achieve superior environmental performances and enhance the Firm's brand. However, the new practices developed to achieve this struggled.

The new waste treatment practices involved long term solutions identified by participants enrolled to address solid waste disposal and water treatment. However, this new development conceived by participants was not implemented (cf. section 6.2.1.1). The cleaner production practices developed to achieve superior water efficiency in production realised a number of quick fixes (cf. Section 6.2.1.2). However, the Water Group established to achieve further efficiency measures was unmade. However, this does not mean that the idea of resource productivity was unmade. Participants in production identified measures in production to improve production output in relation to vegetable inputs. (cf. Section 5.2.10). The marketing practices developed to disclose information about superior environmental performances was found irrelevant (cf. section 6.2.1.3).

A key characteristic found in accounting for strategic practices was the focus on performances required in the longer term to achieve business growth such as superior water treatment capacity, efficiency water use and new brand image. However, the new practices developed to achieve superior environmental performances struggled. Instead, environmental performances such as water use and water treatment were reproduced in existing practices such as in estate management and operational practices. In accounting for these practice categories, environmental performances improved as a result of short term incremental changes. Estate management practices and operational practices are therefore identified as different practice categories found in the Firm. These practice categories consists of *existing practices* found in the Firm such as water treatment and production, and developed in parallel with strategic practices. Details about estate management practices and operational practices are thus covered in the following section.

6.2.2 Estate management practices: October 2008 – October 2010

Estate management practice is a category of practices developed in the Firm to facilitate production in the factory. This includes two types of practices in particular:

- maintenance practices, and
- waste removal practices.

Maintenance practices are developed in the Firm to perform maintenance of technologies in relation to production such as food processing machines, buildings and infrastructure for water supplied to the factory.

Waste removal practices include performances developed in the Firm to remove solid waste streams and effluent water. These practices were found established in the Firm and changed incrementally over time.

6.2.2.1 Maintenance practices

Participants enrolled in estate management practices are engineers working in the Firm with a specific remit to perform maintenance on technologies found in the factory. These technologies include technical devices in production such as food processing machines, and infrastructure such as buildings, complexes of a water system developed to supply water to the factory and complexes of electricity network developed to supply energy to the factory.

In accounting for these estate management practices, environmental performances such as water use and energy use were found constituted, remade and changed in these maintenance practices over time. Details about how environmental performances with reference to water use and energy consumption changed in the estate management practices are provided in subsequent paragraphs.

First, the engineering department was found enrolled in the Firm with a specific remit to perform maintenance on the Firm's infrastructure for water supplied to the factory. The stated aim of this practice was to ensure a supply of clean water to the factory on a daily basis. Technologies involved in this practice include a borehole, water filtration, water pipes, and water pumps. Participants in the Firm, e.g. the Water Engineer, who performed maintenance on these technologies to ensure water supply to the factory, were affected by artefacts developed by other organizations. Among other things, the abstraction license developed by the EA provided details about water quantities allowed per day and water quality requirements developed by food safety organisations who provided details about clean water requirements. A summary of this maintenance practice developed to ensure water supply to the factory is provided in table 6.5.

Table 6-5: Maintenance practice to ensure water supplied to factory

Situation	Main participants	Images of Performances	Technologies
October 2008 to October 2011	Insiders: Engineers, Technical staff Outsiders: EA, Customers, Laboratory,	Water abstraction, water use, water quality	Borehole, water pump, water infrastructures, water meter, water filters, and chemical dosing system, Food Health Standards

Participants enrolled to perform maintenance of infrastructure for water supplied to the factory focused on the quality and quantity aspect of water use. The Water Engineer used a water meter to obtain information about water quantity. The technical department in the Firm enrolled technical staff with specific responsibility to measure water qualities throughout the factory. Concerns about water quantities or qualities in the Firm were constructed in these estate management practices. For example, if one of the water filters in the water borehole was found deteriorating it was replaced by the engineering department. In this way, water supplied to the factory changed via short term incremental actions developed in estate management practices.

Second, the engineering department was found enrolled in the Firm with a specific remit to perform maintenance of the Firm's infrastructure for electricity use. Electricity is used in many operations in the factory such as refrigeration, production and water treatment. A stated aim found in the engineering department was to identify ways to reduce energy consumption. The underlying rationale was to reduce cost related to electricity. Participants in the engineering department were found to have knowledge and expertise as to identify where electricity is used, and in collaboration with others, reduce electricity use in the Firm. Changes in electricity use were achieved in estate management practices.

These included (1) replacement of refrigeration units (cf. Section 5.2.2), and (2) replacement of compressors (see section 4.4.2). A summary of this practice developed in the Firm to reduce electricity consumption using operations is provided in table 6.6.

Table 6-6: Estate management practice developed in the Firm to perform maintenance of electricity consuming operations

Situation	**Main participants**	**Images of Performances**	**Technologies**
October 2008 to October 2011	Insiders: Engineers, H&S Manager, MD1, Environment Officer Outsiders: Energy Provider, Consultant	Energy consumption	National grid, the Firm's infrastructures and energy using devices, Energy meter, FDF Voluntary Agreement, Climate Change Levy

Having described estate management practices developed in the Firm to perform maintenance of the Firm's infrastructure of water supplied to the factory and electricity use in production, the following section provides details about waste removal practices.

6.2.2.2 Waste removal practices

Participants in the Firm's engineering department were found enrolled with a specific remit to complete performances to remove and dispose of waste arising in the factory (cf. 5.2.3). Waste arising in the factory includes (1) solid waste such as cardboard and plastics, (2) organic dry waste such as onion skins, and (3) effluent water, which is water contaminated with organic debris from production. Waste removal practices were found established in the Firm and changed incrementally involving short term fixes realised at certain times. For example, changes in waste removal practices (cf. 5.2.7) involved water treatment in particular.

Water treatment is a performance produced in estate management practices. Participants enrolled to produce water treatment, e.g. the Water Engineer, were found working in conjunction with technologies such as the water treatment plant to complete this performance. This water treatment practice was affected by the water discharge license established by the Environment Agency (cf. Section 5.2.3). Concerns about water use in the Firm identified a discrepancy between present and required water treatment capacity. A project led by the Project Engineer Manager identified and implemented changes to improve water treatment capacity.

The following changes were made (1) replacement of water pumps to improve removal of effluent water from the factory to the treatment plant, and (2) a new water balance tank to increase capacity of the water treatment plant. These changes in the water treatment practice were seen necessary to conform with water use in production and compliance with environmental regulation such as the water discharge license in particular. A summary of waste removal practice developed in the Firm are provided in table 6.7.

Table 6-7: Waste removal practice developed around effluent water

Situation	Main participants	Imagines of Performances	Technologies
October 2008 to October 2011	Insiders: Engineers, Environment Officer, FM 1 and 2 Outsiders The Environment Agency	Water treatment capacity in relation to effluent water arising in production	Water treatment plant and associated infrastructures; devices for solid waste removal and disposal; environmental regulation frameworks

Waste removal practices were found remade over time as to and changed incrementally as to ensure that waste streams are removed and disposed in accordance with specific regulations. A summary of estate management practices found in the Firm is provided subsequently.

6.2.2.3 Summary of estate management practices found in the Firm

Estate management practices found in the Firm include (1) maintenance practices, and (2) waste removal practices. Maintenance practices were found to consist of participants working in the Firm to perform maintenance on technologies such as infrastructure for water supplied to the factory. Waste removal practices were found to consist of participants working in the Firm to produce performances to remove waste arising in production such as effluent water. Problems were found constructed in these practices as a discrepancy between present and required performance. Solutions were found to include enrolment of other participants and technologies to resolve identified problems in the short term. In this way, estate management practices were found reproduced over time and changed incrementally.

Estate management practices were found developing in parallel with production practices. Production practices are one of three operational practices found in the Firm. The other two operational practices are procurement and sales. Details about these operational practices are provided in the next section.

6.2.3 Operational practices: October 2008 to October 2010

Operational is a category of practices found in the Firm and include performances required to make and sell products (e.g. diced potatoes). Practices identified in the Firm to achieve this are: procurement, production and sales. These practices are inter-linked and produce a number of performances such as buying vegetables, producing finished products and selling these to customers. These practices were found remade everyday, but to an established format and changed only incrementally over time. Details about these operational practices and how they changed are as follows.

6.2.3.1 Procurement and sales

Procurement and sales are two distinct practices found in the Firm and are inter linked. Procurement consists of participants in the Firm (e.g. procurement manager) working in conjunction with technologies (e.g. food protocols) to buy vegetables from primary producers such as farmers (cf. section 4.2.1). Vegetables selected by participants in procurement practices are affected by sales practices. Sales practices consist of participants in the Firm (e.g. sales manager) working in conjunction with technologies (e.g. customer orders) to sell finished products to customers. Procurement practice and sales practices are therefore interlinked. Performances such as procurement of vegetables are affected by customers via specific food protocols such as Field to Fork, Tesco Natures Choice and LEAF (cf. section 4.2.1.1.) The vegetables are transformed in production, which is a third practice interlinked in operations. Details about production practices are provided subsequently.

6.2.3.2 Production practices

Production practises consist of participants in the Firm, e.g. managers and staff, working in conjunction with technologies, e.g. food processing machines, to produce pre-cut vegetables. Production practices such as peeling, dicing and packaging, were remade every day and changed incrementally over time (cf. Section 4.2.1.2). A particular focus in production practices was to improve yields (cf. section 5.2.10). In subsequent events, FM2 was enrolled by MD2 to take leadership in the Firm's operations (cf. section 5.2.11). FM2 worked in collaboration with other participants in the Firm (e.g. Planning Manager and Production Manager) to identify performances required as to complete production throughput.

An overall Operational Management Framework was developed and identified several key performances (e.g. customer service). FM2 enrolled a NOBO board in the daily production meetings to display those performances required. The NOBO board was used to organise the daily review of performances and is an ordering device that helped participants in production practices to see and account for identified performances. This new development in the production practices inspired work related to environmental performances.

The FM2 appointed the Water Engineer as Environmental Officer in the Firm (cf. Section 5.2.12). In this new role, the Environmental Officer developed an environmental reporting framework. This was a new practice developed in the Firm's operations. The Environment Officer worked in conjunction with technologies (e.g. the environmental reporting framework and monitoring devices such as water meters) to produce information about environmental performances. A NOBO board was developed by Environment Officer and the Researcher. The purpose of this NOBO board was to display information about energy consumption and water used in production at production meetings. However, this NOBO board struggled to achieve attention among other participants in the Firm. A summary of production practices developed in the Firm is provided in table 6.8.

Table 6-8: Production practices

Situation	**Main participants**	**Images of Performances**	**Technologies**
October 2008 to October 2011	Insiders: FM1, FM2, production staff, MD1 and 2 Outsiders: Customers, suppliers	Procurement, production and sales	Food production equipment and infrastructure, Factory Management Framework, NOBO board

Production practices were found to change incrementally to achieve superior environmental performances. For example, changes in water use were achieved as a result of technical fixes implemented in production (cf. 5.2.13). These changes included (1) a water recycling device installed in one of the food processing machines, and (2) a separate water unit installed to facilitate cleaning operations in the factory. A summary of operation practices found in the Firm are detailed subsequently.

6.2.3.3 Summary of operational practices

Operational practices found in the Firm include three inter-linked practices: procurement, production and sales. Participants in these practices were found working together with technologies to produce performances. For example, the procurement manager drew on specific food protocols to select and buy vegetables from primary producers. The Sales manager drew on customer orders to complete sells to customers. Production managers were found working in conjunction with technologies to produce pre-cut vegetables. These practices were found reproduced over time involving incremental changes. Environmental problems and solutions were found constructed in these practices by participants in relation to their images of resource productivity. For example, changes in production practices involved new developments to achieve, among other things, higher product yields.

Having described operational practices, the following section provides details about the strategic practice developed at the Parent Group. This strategic practice identified the need to develop and implement a Sustainability Strategy in the Firm.

6.2.4 The development and implementation of the Sustainability Strategy: August 2010 – October 2011

A sustainability strategy was identified at Parent Group in August 2010 and developed through subsequent events (cf. Sections 5.2.16 and 5.2.17). This sustainability strategy identified performances required in terms of economic, social and environment based on a broadly applied model that has developed in other sectors of society such as business organisations, and is commonly framed as the entities of sustainability. The Parent Group enrolled a Group Sustainability Champion (GSC) with specific remit to develop and implement this strategy in the Firm and the other divisions in the Group. The GSC was before this role appointed in the Firm as Sales Director and then as commercial developer at another subsidiary of the Group. His experience of the commercial context in this sector suited for this work on the Sustainability strategy.

The GSC identified the sustainability strategy developed by M&S, which was also one of the Firm's customers, and used this framework as the model for the Group Sustainability strategy. Additionally, the FDF voluntary agreement was identified to provide guidance regarding performances required in this sector with respect to sustainability. The M&S sustainability strategy and FDF voluntary agreement are here treated as technologies enrolled by the GSC in the development of this Sustainability strategy. This is therefore seen as a new strategic practice, developed at Parent Group, and in the Firm.

The GSC enrolled the Environment Officer and other actors from each Group Division to participate in the development of this sustainability strategy. A series of meetings were held to develop this strategy and five sustainability pillars was identified. These are: (1)

social responsibility; (2) raw materials; (3) natural resources; (4) transport; and (5) waste streams (cf. Section 5.2.17).

This sustainability strategy invaded Firm practices and enrolled actors (the Environment Officer and FM2) to identify ways to improve environmental performances. For example, reducing energy consumption was identified in the Firm. FM2 enrolled the Engineer Manager to identify and install new compressors. Water use was another performance identified necessary to resolve. A discrepancy was identified between present and required water use in the longer term. The GSC argued that changes in future water demand and regulation could affect the water supplied to the Factory. This problem was defined more widely and also included those growers that supply raw materials to the Firm: if they struggle with water they would struggle to produce raw materials. The Researcher was enrolled in a project, led by GSC, to identify factors that could affect future water use in the Firm and water used by the Firm's suppliers.

This strategic practice, involving the sustainability strategy, was created at Parent Group and the Firm, and invaded a number of Firm practices. This strategic practice identified new performances (e.g. water use among Firm's suppliers) and enrolled actors (e.g. the Researcher) and technologies (e.g. water footprint) to achieve this. A summary of this new practice developed in the Firm is provided in table 6.9.

Table 6-9: Strategic practice developed in the Firm

Situation	Main participants	Images of Performances	Technologies
August 2010 to October 2011	Insiders: Parent Group, GSC, Environment Officer, FM2, the Researcher Outsiders:	Business continuity: access to, and availability of, factor inputs, e.g. energy, water and raw materials	M&S Plan A; FDF voluntary agreement

A summary of this strategic practice is provided subsequently.

6.2.4.1 Summary of strategic practice

This strategic practice consists of participant in the Firm, e.g. the Environment Officer, working in collaboration with other participants, e.g. the GSC, and technologies, e.g. M&S Plan A and the FDF voluntary agreement, to produce performances such as contingency plan for water use in the Firm in the longer term. The underlying rational in this strategic practice was therefore business continuity in the longer term. This strategic practice involving a sustainability strategy developed in parallel with operational practices and estate management practices found in the Firm. The Sustainability Strategy was found to guide participants in the Firm to identify ways to achieve superior environmental performances such as water use and energy consumption. Having described the environmental innovation journey, conceptualised as social practices, a summary and critical reflection is now provided.

6.3 Summary and critical reflection

This section provides a summary and a critical reflection of the environmental innovation journey conceptualised as social practices. First, the summary provides details about the key findings from exploring the environmental innovation journey, conceptualised as social practices found in the Firm. Second, a critical reflection identifies the limitations of the environmental innovation journey conceptualised as social practices. Discourse analysis is proposed to explore and account for competing environmental discourses.

6.3.1 Summary of the environmental innovation journey conceptualised as social practices

An account of the environmental innovation journey, conceptualised as a social process, involving the construction of environmental problems and solutions was presented in chapter 5. The environmental innovation journey was found to be a non linear process involving temporary fixes that are reversible. The key characteristics of this process was (1) multiple and consists of many participants and technologies, (2) environmental problems and solutions are constructed and contingent upon images of environmental problems and performances required to resolve these, and (3) fluid as the development of novelty is ongoing involving temporary fixes that are reversible and shaped by multiple and competing imaginings. Practice theory of innovation was identified in literature (cf. Shove and Walker, 2010; and Pantzar and Shove, 2010) and offered a way to make sense of the environmental innovation journey conceptualised as social practices.

An interpretive framework, inspired by literature on this practice theory of innovation, was developed in this chapter to account for the environmental innovation journey conceptualised as social practices found in the Firm. This interpretive framework consists of: (1) participants, (2) images of performances, and (3) technologies. Social practice is a process in which participants work in conjunction with technologies to produce performances in relation to their imaginings of environmental problems and performances required to resolve these. Discrepancy between existing performances and images of performances required of practices stimulates change in practices. In accounting for this process, new practices are made, reproduced or deleted over time.

In accounting for the environmental innovation journey, conceptualised as social practices, this analysis presented in chapter 6 has provided a rich and detailed picture of how environmental innovation is constructed and proceeds over time. Environmental problems and solutions are constructed in many inter linked practices. Three practice categories were identified: (1) strategic practices, (2) estate management practices, and (3) operational practices. In accounting for these practices four discrete processes of how practices change were identified.

- Participants working together to conceive and create new practices in which participants and technologies are drawn together for the first time to produce new performances required
- Participants working together to reproduce practices and conceive and create change as necessary to maintain or improve performances, in which practices change incrementally
- Practices and performances that are no longer warranted are deleted and the relationships between the elements that sustain practice are broken and performances are unmade
- The environmental innovation journey consists of many interlinked practices found in, but not limited to, the Firm. A change in one practice therefore affects other practices and performances.

The key findings of an environmental innovation journey conceptualised as social practices are: (1) social practices consist of participants working in conjunction with technologies to produce performances, and (2) change in social practices involves four distinct processes as described above. How change in practice occurs is described in greater detail below.

6.3.1.1 How social practices change

This section draws on the social practices found in the Firm and the four distinct processes, identified above, to describe how social practices change. One example is provided for each distinct process: (1) how new practice is made, (2) how practices are reproduced, (3) how practice is deleted, and (4) how change in one practice affects other practices.

First, strategic practices found in the Firm consist of new developments guided by the development and implementation of the Environmental Strategy (cf. section 4.4, 5.2.1, 5.2.7 and 6.2.1). New practices conceived by participants, e.g. MD1, in the Firm were (1) waste stream practices, (2) cleaner production practices, and (3) marketing practices. A summary of new practices conceived by participants are provided in table 6.10 below.

Table 6-10: Strategic practices: development and implementation of the Environmental Strategy

Situations	Main participants	Images of performances	Technologies
October 2008 to March 2009	MD1; Group Advisor; Water-treatment-Consultant; Organic-Waste-consultant; Researcher	Enhanced end-of-pipe capacity required to meet the need for future production throughputs	Water treatment plant; MBR; AD; Investment appraisal; The Environmental Strategy
April 2009 January 2010	Insiders: MD1, FM1, Researcher, Supervisor 1, Production Manager, the Water Engineer Outsiders: Marketing Consultant, FDF	Improve water efficiency through cleaner production practices to ease pressure on water treatment plant	Water use devices; FDF voluntary framework; Factory Management Framework; water treatment plant, The Environmental Strategy
June 2009- January 2010	Insiders: MD1, Researcher, Supervisor 1, Sales Director, Commercial Director Outsiders: Marketing Consultant, customers	Brand image with reference to environmental performances to attract existing and future customers and enable business growth	Website and other forms of marketing channels, the Environmental Strategy; Firm's brand

In this account of strategic practices found in the Firm, new practices were conceived by participants such as new waste stream practices, new cleaner production practices and new marketing practices. While new waste stream practices (cf. sections 6.2.1.1) did not proceed to become new practices, cleaner production practices and marketing practices did proceed into new practices in the Firm. A cleaner production practice to reduce water use (cf. section 6.2.1.2) consisted of participants working together and identified squeegee and shovel to clean factory floors from debris during production rather than using open hosepipe. Participants, e.g. FM1, in the Firm enrolled other participants, e.g. production staff, and technologies (i.e. squeegee and shovel) to clean the floor. In this way, water use in production was reduced. This practice was remade.

A new practice found in the Firm was the new marketing practices. This practice consisted of participants, e.g. MD1, working in collaboration with others, e.g. the Marketing Consultant, to create new marketing practices so as to disclose information about superior environmental performances. In this practice, new performances were made such that information about environmental performances was produced on a website. However, this marketing practice struggled to achieve further development as conceived by participants, e.g. MD1. This marketing practice developed in the Firm to disclose information about the Environmental Strategy was deleted. The relationship between the elements that was found in the Firm to sustain this marketing practice was broken. Seen this way, social practices are reversible.

Second, estate management practices found in the Firm consist of established practices such as maintenance practices and waste treatment practices. These practices were found to reproduce performance such as water use and water treatment in the Firm over time. In accounting for these estate management practices it was noted that change occurred incrementally at certain times. A summary of estate management practices is provided in table 6.11.

Table 6-11: Estate management practices

Situation	Main participants	Images of Performances	Technologies
October 2008 to October 2011	Insiders: Engineers, Technical staff Outsiders: EA, Customers, Laboratory,	Water abstraction, water use, water quality	Borehole, water pump, water infrastructures, water meter, water filters, and chemical dosing system, Food Health Standard
October 2008 to October 2011	Insiders: Engineers, H&S Manager, MD1, Environment Officer Outsiders: Energy Provider, Consultant	Energy consumption and reduce cost of energy consumption	National grid, the Firm's infrastructures and energy using devices, Energy meter, FDF Voluntary Agreement, Climate Change Levy
October 2008 to October 2011	Insiders: Engineers, Environment Officer, FM 1 and 2 Outsiders The Environment Agency	Water treatment capacity in relation to effluent water arising in production	Water treatment plant and associated infrastructures; devices for solid waste removal and disposal; environmental regulation frameworks

Performances produced in estate management practices such as water supplied to the factory and water treatment was found reproduced over time and changed incrementally. For example, water supplied to the factory was a performance made every day. Participants, e.g. the Water Engineer, were enrolled with specific remit to maintain this performance, in relation to their imaginings of performances required such as specific water qualities and quantities. Concerns about water qualities and water quantities identified solutions in the short term to sustain performances required. Compliance with water abstraction license and food safety standards affected change in this maintenance practice. Incremental changes were accounted for such as replacement of deteriorating water filters.

In similar vein, waste treatment practices changed incrementally. Participants, e.g. the Water Engineer, enrolled with specific remit to sanitise water arising in production were working in conjunction with technologies such as the water treatment plant. Participants, e.g. the Water Engineer, was working in collaboration with others and conceived and created change as necessary to uphold water treatment performances. For example, a replacement of water pumps by more efficient ones improved removal of effluent water from the factory. Furthermore, a new water holding tank improved the water treatment capacity (cf. section 6.2.2.2). In this way, waste treatment practices to produce water treatment performances changed incrementally over time to uphold this required performance. Similar to estate management practices, described above, operational practices such as procurement, production and sales was found to change incrementally over time.

Third, new strategic practices developed at Parent Group and affected practices in the Firm. Work on the Sustainability Strategy, led by GSC, consisted of participants in the Firm, e.g. the Environment Officer, working in conjunction with technologies (e.g. M&S Plan A and FDF voluntary agreement) and identified key principles relating to an image of sustainability. A summary of this new strategic practice is provided in table 6.12.

Table 6-12: sustainability practice

Situation	Main participants	Images of Performances	Technologies
August 2010 to October 2011	Insiders: Parent Group, GSC, Environment Officer, FM2, the Researcher Outsiders:	Business continuity: access to, and availability of, factor inputs, e.g. energy, water and raw materials	M&S Plan A; FDF voluntary agreement

A key development in this new practice was the Sustainability Strategy developed at the Parent Group. This strategy affected practices, e.g. estate management practices and operational practices in the Firm. For example, waste treatment practices in the Firm were conceived as unsustainable in the longer term. Participants, e.g. the GSC, working in collaboration with others identified future change in water legislation and water demand in the UK. These changes were seen as to have an effect on the Firm's water use. New performances such as water recycling were therefore found necessary to pursue. In similar vein, constrained access to water among the Firm's suppliers, i.e. farmers, can hinder the supply of vegetables to the factory. Hence, new procurement arrangements were conceived necessary in the future.

The environmental innovation journey, conceptualised as social practices, identified that (1) participants work in conjunction with technologies to produce performances, and (2) social practices change as new practices are made, reproduced, deleted, and affected by other practices. This summary has provided details about the environmental innovation journey conceptualised as social practices. A critical reflection of making sense of the environmental innovation in this way is provided subsequently.

6.3.1.2 Critical reflection on the role of the Researcher

As described in section 5.3.1.4 the researcher's role in this study was twofold (1) participating in the environmental innovation journey, and (2) reflecting on this process so as to make sense of it. Following the events in the Firm taking place during the period October 2008 to January 2010, the Researcher produced the following key insights. First, that environmental innovation is messy and complex. However, this does not mean that other participants in the Firm viewed what went on in the Firm in this way. In other words, this messy and complex account is an interpretation by the Researcher, which was produced in light of literature, in which such process is often presented in stylised accounts. A second insight identified key characteristics of the environmental innovation journey; these are (1) non-linear, (2) ongoing, (3) multiple actors, and (4) reversible.

The idea the environmental innovation journeys can usefully be conceptualised as social practices thus emerged in this study. This view was therefore that of the Researcher and not necessarily that of other participants in the Firm. In other words, the Researcher found it useful to draw on theories of practice identified in literature to make sense of the environmental innovation journey.

This idea to draw on theories of practice stimulated further research. Data collection continued while alternative approaches were sought in literature to aid sense making. This literature review identified a study that draw on theories of practice to understand innovation and change. This practice approach was found useful for two reasons. First, theories of practice offer a way to make sense of the mundane doing of everyday life in the Firm and how practices change. Second, theories of practice accord with the constructivist perspective adopted in this study.

This insight led to research objective 4 and the research process was refined. This means that data collection and analysis, following this period (June 2010), focused on social practices. In other words, the view of the researcher changed from a focus on environmental innovation conceptualised as a social process to a focus on social practices. Data collection via ethnographic methods that focused on social practices continued to October 2010. Time spent in the Firm during this period was 2-3 times per week.

The Researchers interpretation on what went on in the Firm focusing on social practices was useful in order to identify how practices might change. For example, the Researcher facilitated the introduction of recycling bins for solid waste in the Firm. This introduction of a new technology (e.g. bins and informative signs) helped participants in the Firm to improve recycling solid waste, e.g. cardboard and plastics. This practice approach also provided new insight on how environmental innovation in a firm can be accounted for. More specifically, a critical reflection on this change in waste treatment practice identifies that a practice can change. It also shows that, while a practice such as that of solid waste treatment can change, this does not mean that the vision that end-of-pipe treatment of solid waste provide adequate mean to address such issues changed. In other words, a move beyond end-of-pipe innovation requires a change in the vision of associated practices in this Firm.

The presence of the Researcher was important to account for the environmental innovation journey conceptualised as practices. However, the role of the Researcher changed following a particular event in the Firm. This event involved the Sustainability Director appointed by the Parent Group to develop a Sustainability Strategy. The Researcher was invited to engage in this project, which focused on issues at a strategic level. It was therefore found useful to spend less time in the Firm and more time at the University. The time spent in the Firm was therefore one visit per month during the period November 2010 to October 2011.

Drawing on theories of practice, this analysis showed that it was not possible to take this practice approach of the shelf to make sense of the environmental innovation journey in the Firm. Studies found in literature that draw on theories of practice concentrate on distinct practices in terms of what people do e.g. cooking or cycling and the associated elements. In contrast, practices in a firm are multiple and interlinked and therefore difficult to disaggregate. Hence, the interpretive framework and analysis emerged through a dialogue between literature on theories of practice and data collected in the Firm.

This analysis of the environmental innovation journey conceptualised as practices produced the following key insights. First, theories of practice offer a valid approach to make sense of environmental innovation journeys in a firm without making a mess accounting for it. Second, theories of practice do not offer insight to what shape practices in a firm. The second insight stimulated further research and led to research objective 5.

6.3.2 Critical reflection and limitations

This chapter has focused on account of the environmental innovation journey conceptualised as social practices. Making sense of the environmental innovation journey in this way was found to accord with the characteristics identified in chapter 5. The environmental innovation journey, conceptualised as social practices, accounted for many inter linked practices found in the Firm. Hence, rather than a distinct process such as the unilinear model (cf. Van de Ven et al., 1999) this practice theory of innovation accounts for multiple trajectories that develop across time and space. Participants conceive and create new practices and change in existing ones in relation to their imaginings of environmental problems and performances required to resolve these. Seen this way, social practices are undertaken for a reason, and change in social practices is shaped by participants in relation to their imaginings of present and required performances. However, this practice theory of innovation does not account for how imaginings are made and shape social practices.

This insight stimulated further research to seek to understand how imaginings are made and shape the environmental innovation journey conceptualised as social practices. More specifically, to seek new insights as to understand why new practices are developed, why certain practices are reproduced and change incrementally, while certain practices are deleted. Drawing on literature that identifies competing environmental discourses to understand change in social practices (cf. Hajer, 1995; Guy and Farmer, 2001), discourse analysis offered a way to make sense of change in social practices found in the Firm. Seen this way, imaginings of present and required performances to resolve environmental problems are shaped by environmental discourses. The environmental innovation journey, conceptualised as social practices, involving competing environmental discourses is explored in the subsequent chapter.

7 Making sense of the environmental innovation journey, conceptualised as social practices, involving competing environmental discourses

This chapter draws on literature that explores discourse analysis (cf. Hajer, 1995; Guy and Farmer, 2001) to make sense of the environmental innovation journey conceptualised as social practices involving competing environmental discourses. The content of this chapter is summarised in text box below.

7.1	**Introduction**	The introduction identifies the research perspective developed to account for the environmental innovation journey conceptualised as social practices involving competing environmental discourses. This insight identifies research objective 5. Details about the approach and method to undertake discourse analysis is provided including the interpretive framework to account for environmental discourses
7.2	**Making sense of the environmental innovation journey**	This section provides details about environmental discourses found in the Firm. Four distinct discursive orders are identified. These are (1) eco-prenurial, techno-centric, operational running and sustainability.
7.3	**Summary and critical reflection**	The summary identifies the key findings of making sense of the environmental innovation journey. A discourse analysis identifies how environmental discourses shape, and are shaped by, social practices. The critical reflection identifies the utility of making sense of the environmental innovation journey conceptualised as social practices involving competing environmental discourses.

7.1 Introduction

The focus of this chapter is discourse. The idea of discourse derives from theories rooted in social sciences that aim to understand how we make sense the world around us. In Dryzeck (2005) discourses are embedded in language: "*a discourse enables those who subscribe to it to interpret pieces of information and put them together into coherent stories or accounts. Discourses constructs meanings and relationships, helping to define common sense and legitimate knowledge*" (Dryzek, 2005)

The introduction to this chapter consists of two components. First, details of the research perspective to make sense of the environmental innovation journey conceptualised as social practices involving competing environmental discourses. Second, the method identified in literature to undertake a discourse analysis is described. Details about the method identify the interpretive framework developed in this study to explore environmental discourses in the Firm.

7.1.1 Research perspective

An account of the environmental innovation journey, conceptualised as a social process, was presented in chapter 5. Environmental innovation is a social process and is made through interaction and negotiation between participants to create something to resolve environmental problems. Chapter 6 drew on practice theory of innovation and identified the concept of social practices to make sense of the environmental innovation journey. A social practice consists of participants working in conjunction with technologies to produce performances. Innovation in social practices consist of participants working together to conceive and create new practices, and create change in established practices, in relation to their imaginings of environmental problems and solutions required to resolve these.

The nature and direction of the environmental innovation journey was found shaped by participants in relation to social constructs: imaginings about environmental problems and solutions. Seen this way, environmental innovation is shaped by competing imaginings: discrepancies between present and required performances produced in social practices. However, the analysis of social practices was found to be limited in providing understanding how imaginings are made and shape the nature and direction of the environmental innovation journey: how new practices develop and persist, how established practices are reproduced and change incrementally, and how certain practices are deleted.

This chapter draw on discourse analysis to make sense of competing imaginings of environmental problems and solutions found in chapter 6. The following research objective was developed around this purpose:

- **Research objective 5:** to identify and critically reflect on the environmental innovation journey conceptualised as social practices involving competing environmental discourses.

7.1.2 Approach to discourse analysis

Discourse analysis is a method used in social sciences to understand social processes such as environmental policy and planning (Sharp and Richardson, 2001). The purpose of undertaking discourse analysis is to understand how discourses and change in discourses affect social change. However, widely different approaches to discourse analysis exist. Gill (2000) identifies 57 different varieties of discourse analysis. A discourse analysis is therefore determined by the researcher and his understanding of the term discourse. A simplified distinction of the many approaches to discourse analysis is provided by Fiendt and Oels (2005) who suggests there are two broad strands in this field of research. These are (1) the foucauldian and (2) the non-foucauldian approach to discourse analysis.

The non-foucauldian perspective is characterised by its linguistic type approach focusing on language and its use (Habermas, 1994). In this understanding of discourse, environmental discourse consists of text such as speech and written documents (Hastings, 1999). The purpose of undertaking this approach to analyse discourses is to identify how ideas and concepts produce meaning. For example, Huber (2001) explores how humans relate to the natural environment by identifying particular environmental discourse topics such as air quality, environmental protection and climate change. The way these topics are constructed in texts shape the meaning about environmental problems and solutions. This strand of discourse analysis therefore aims to provide detailed analysis on what is said or written in accounting for discourses in social processes.

In contrast, the foucauldian approach to discourse analysis focuses on knowledge rather than language. Here, a discourse is viewed as a claim to knowledge and accounts for what people say (claim to knowledge) and do (action). In practice, Hajer follows this foucauldian approach and defines discourses as *"a specific ensemble of idea, concepts and categorisation that are produced, reproduced and transformed in a particular set of practices through which meaning is given to social and physical realities"* (Hajer, 1995:44).

This foucauldian approach to discourse analysis focuses on claims to knowledge. A claim to knowledge is viewed as an established truth on the basis that it is socially accepted. Claims to knowledge that are socially accepted are powerful. Power and knowledge are therefore interlinked in discourses (Foucault, 1976; and 1975). Seen this way, discourse analysis focuses on claims to knowledge and how discourses render certain knowledge legitimate, while delegitimizing other claims to knowledge.

This foucauldian approach to discourse analysis identifies three characteristics of discourses:

- First, discourses are claims to knowledge produced in social practices and which shape social practices. Power and knowledge is therefore interlinked. However, this understanding of discourse and power does not view discourses as a medium through which humans can manipulate the world around them. Discourses are rather viewed as discursive 'software': forms of knowledge found in social practices and which affect the development of social practices.
- Second, discourses are not limited to distinct practices, but rather travel in and through many interlinked social practices.
- Third, social practices are sites that consist of multiple and competing claims to knowledge.

In accounting for discourses following this foucauldian approach, discourses are viewed as discursive software (Foucault 1976), while social practices are the hardware that produces performances. Social practices consist of participants working in conjunction with technologies: a set of interlinked subjects and objects that produce performances. Change in social practices is shaped by the enrolment of new objects, new subjects and new forms of problematizations found in social practices. These forms of changes are treated as indicators of the discursive order that shapes social practices.

In accounting for the discursive order found in social practices, discourses are claims to knowledge and treated as stories (Hajer, 1995). In this way, a discourse analysis accounts for knowledge as stories and the social practices in which stories are told and shape social practices. The discursive order that shapes social practices consists of persuasive and pervasive stories. Persuasive stories refer to knowledge that is accepted in social practices, and pervasive stories refer to knowledge that renders legitimacy to (change in) social practices.

This approach to discourse analysis accords with the constructivist approach adopted in this study. Discourses are claims to knowledge and consist of stories that are socially constructed. Seen this way, knowledge about sustainability is multiple and contested and shifts across time and place (Guy and Farmer, 2001). A discourse analysis was therefore found useful to pursue in this study to explore how competing environmental discourses shape social practices found in the Firm.

In this approach to discourse analysis, social practices are treated as the hardware that produces performances, while discourses are the software. Social practices, the hardware, consist of participants working in conjunction with technologies to produce performances. The analysis of social practices, in chapter 6, identifies participants as the prime mover: participants enrol other participants and technologies in relation to their imaginings of environmental problems and solutions required to resolve these. A discourse analysis, on the other hand, focuses on the discursive order, the software, holding social practices together. Changes in the discursive order affect social practices. This approach to discourse analysis decentres participants as the prime movers and centres discourses.

Having described the approach to discourse analysis identified for this study, the following section draws on literature that explores environmental discourses and identifies a way to understand environmental discourses found in the Firm.

7.1.3 Environmental discourses

Environmental discourses are knowledge about environmental problems and solutions constructed in social practices. In environmental politics, Dryzek (2005) identifies environmental discourses with reference to, among other things, the natural environment, technologies and governmental intervention. In accounting for environmental discourses in this way, Dryzek (2005) classifies nine distinct environmental discourses found in society. These are shown in Table 7.1.

Table 7-1: Environmental discourse categories
(Adopted from Dryzek, 2005)

Environmental discourse	Central meaning of discourse
Prometheanism	Nature is brute matter, but humans are dominant. In developing superior technologies there is no need for governmental intervention or to develop distinct solutions to environmental problems
Economic rationalism	Humans are rational agents. Market competition is central, but needs regulation, e.g. command and control, to protect the environment. Technologies are essential to protect the environment and are developed on an ad-hoc basis
Administrative rationalism	Liberal capitalism is central involving administrative state intervention. Humans are dominant in relation to the natural environment. Technologies are trusted and developed by experts to protect the environment.
Ecological modernization	Capitalist economy based on market principles. Environmental protection and social prosperity goes hand in hand. Development in technologies emphasised.

Sustainability	Ideas about social, economic and ecological prosperity are interlinked. Environmental stewardship is emphasised, involving global equity and environmental justice.
Survivalism	Concerns about finite natural resources and the carrying capacity of ecosystems.
Green radicalism	Nature is dominant. Strives for equity across people and nature

This approach to analyse environmental discourses is found in studies to understand the nature of environmental problems and solutions constructed in specific political contexts. Cook and Walker (2009) follow Dryzek (2005) and explore environmental discourses found in the UK aviation policy. In their study, Cook and Walker identify distinct groups in relation to UK aviation such as NGOs[25], airlines, regulator and trade associations. In accounting for these disparate groups, they identify different views about environmental problems and solutions in relation to aviation and sustainability. Sustainable aviation is therefore found to be a contested field and consists of multiple and competing views. The groups identified in relation to aviation were found to reframe aviation policy in light of their own interest. Seen this way, social groups consist of participants that are actively involved in the mobilisation and transformation of environmental discourses (Hajer, 1995). A discourse analysis identifies environmental discourses and reveals competing claims to knowledge.

In a different study, Guy and Farmer (2001) explore how environmental problems and solutions are constructed in architecture. In accounting for sustainable architecture, Guy

[25] NGO: Non Governmental Organization

and Farmer (2001) identify the two discourse categories: the place of buildings and the use of technologies in relation to the natural environment. In this way, Guy and Farmer (2001) account for multiple environmental discourses in relation to building design and sustainability.

Having described different studies that explore environmental discourses, the following section provide details about an interpretive framework developed in this study to account for environmental discourses found in the Firm.

7.1.4 Interpretive framework

The interpretive framework developed in this study to make sense of environmental discourses found in the Firm follows the foucauldian approach to discourse analysis. This approach is found in studies by Hajer (1995) and more recently Guy and Farmer (2001) to make sense of knowledge about environmental problems and solutions which are produced and shape social practices such as policy practices and architectural practices. The interpretive framework developed intimately with data collected in the Firm using ethnographic methods and literature on discourse analysis.

The interpretive framework consists of analytical categories inspired by literature (c.f. Guy and Farmer, 2001) to make sense of environmental discourses found in the Firm. The analytical categories are:

- image of the natural environment;
- source of knowledge;
- image of the commercial context;
- image of technologies, and

- time horizons.

Details about these analytical categories are provided in the interpretive framework provided in table 7.2.

Table 7-2: Interpretive framework to make sense of environmental discourses (adopted from Farmer and Guy, 2001)

Discursive concepts	Description
Source of knowledge	How knowledge about environmental problems and solutions is constructed in social practices
Image of the natural environment	How the natural environment is conceived in social practices
Image of the commercial context	How social practices conceive success in the commercial context
Image of technologies	How technologies are conceived in relation to environmental problems and solutions
Time horizons	How time horizons are conceived in social practices

This interpretive framework was developed to make sense of the discursive order: the software that shapes the environmental innovation journey conceptualised as social practices. In accounting for environmental discourses, this analysis focuses on stories produced in social practices and shapes the development of these. The following section explores environmental discourses found in the Firm.

7.2 Exploring environmental discourses found in the Firm

This section provides the findings from discourse analysis. Details about environmental discourses found in social practices are structured into four sub-sections:

- environmental discourses found in strategic practices,

- environmental discourses found in estate management practices,
- environmental discourses found in operational practices and
- environmental discourses found in operational practices.

7.2.1 Environmental discourses found in strategic practices

The strategic practices found in the Firm refer to the development and implementation of the Environmental Strategy (cf. section 4.4, 5.2.1, 5.2.7. and 6.2.1). The stated aim of this strategy was to enhance the Firm's competitive advantage by improving environmental performances in several areas such as energy consumption, water use and solid waste generation. In accounting for this strategic practice, MD1 was found working in collaboration with other participants, e.g. the Group Advisor and the Operational Director, and drew on ideas of resource productivity to achieve superior environmental performances in the Firm.

The underlying rationale to focus on resource productivity was the idea of win-win solutions: improvements in production throughputs via efficiency gains can reduce cost of production and thereby enhance profit. For example, the Operational Director built on lean manufacturing, a well established concept found in manufacturing management to enhance product throughput in the factory. The focus on lean manufacturing identified transformation of vegetables as the critical performance in production. However, this focus was replaced by a factory management framework entitled Daily Reviews (cf. section 5.2.6).

Participants in the Firm conceived and created new practices such as cleaner production practices and marketing practices (cf. section 6.2.1). These new practices were found necessary to enable business growth and business continuity in the longer term. Work on the Environmental Strategy was seen as "*a great story, big point of difference*" (MD1, June 2008). It was argued by MD1 that superior environmental performances would differentiate the Firm from its competitors and attract existing and future customers. Seen this way, the natural environment was conceived as a strategic partner. The natural environment provides resources such as water that are necessary to the Firm.

"*One of the advantages that we got is this whole thing on water and effluent. The reason why is because we got our own borehole*" (cf. section 4.2.1.1). The Water "*comes up through the sand, so it is fantastic water, and then we wash the vegetables*".

(MD1, June 2008)

Work in the Firm to develop and implement the Environmental Strategy enrolled other participants such as consultants to identify technologies to achieve superior environmental performances. For example, the Group Advisor worked in collaboration with a water treatment consultant and identified MBR to improve water use in the Firm (cf. section 5.2.4 and 6.2.1.1). Although this technology was not implemented, this event shows that solutions were sought on the basis of (1) a certain time horizon, and (2) the symbolic value of technology. First, MBR technology is useful because water that has once been used can be recycled back to the factory. This was found necessary as existing practices around water use are constrained by the water abstraction license. Second, water recycling is seen as good environmental practice in the industry (see for example the FDF voluntary commitment) and can therefore attract those customers who care about such environmental initiatives. Seen this way, technologies such as MBR symbolise a green image and are easily displayed because it is easy to relate to and provide information about them.

Work on the Environmental Strategy therefore conceived and created new marketing practices in the Firm to disclose information about superior environmental performances (cf. section 6.2.1.3). However, this focus on environmental performances in marketing was contested by other participants in the Firm. Among others, the Marketing Consultant argued that customers (i.e. ready meal manufacturers) are not interested in environmental performances. Information about environmental performances can be disclosed, however, only as long as this information does not distract information about product qualities (Marketing Consultant, September 2009). In a similar vein, the commercial director argued that the Environmental Strategy was the wrong focus in the Firm as illustrated in the following quote:

"There is no point to get the Environmental Strategy *if we can't deliver the right quality and the right products to the right price"*

(Commercial director, January 2010).

Work to develop and implement the Environmental Strategy created and conceived strategic practices such as cleaner production practices and marketing practices. However, the development of these new practices was contested (cf. section 5.2.8 and 6.2.1.4). The Environmental Strategy was seen as irrelevant at the time and put on hold (cf. section 5.2.10). Strategic practices involving work on the Environmental Strategy developed for some time. A distinct environmental discourse was found shaping the development of strategic practices in the Firm. This environmental discourse is labelled eco-prenurial. A summary of this environmental discourse is provided in table 7.3.

Table 7-3: Eco-prenurial

Discourse	Source of knowledge	Image of the natural environment	Image of the commercial context	Image of technology	Time Horizon
Eco-Preneurial	Market actors, university, consultants	Local, Strategic partner, romantic	Competitive, resource productivity, brand differentiation,	Symbolic value	Long term survival; future markets

The term eco-prenurial is an amalgamation of the two concepts ecological and entrepreneurial. This environmental discourse consisted of claims to knowledge that emphasised a focus on environmental performances as means to create competitive advantage. Knowledge sourced to achieve superior environmental performances derived from market actors' such as customers, university involving sponsorship of this PhD project, and collaboration with consultants such as Marketing Consultants.

Strategic practices conceived success as profitability. New practices developed to achieve profitability were found guided by stories about resource productivity (cf. section 6.2.1). In this strategic practice, competition was identified as a key challenge. Brand image and differentiation was therefore identified as necessary to achieve long term survival in this commercial context. However, this eco-prenurial discourse struggled to compete with other environmental discourses. For example, while work to develop and implement the Environmental Strategy focused on developments in the longer term such as new marketing practices, other social practices prioritised new developments in existing practices in the shorter term. This strategic practice was therefore deleted.

Eco-prenurial is one discursive order found in the Firm and shaped development of new practices such as cleaner production practices and marketing practices. However, this environmental discourse struggled to compete with other environmental discourses found in the Firm. Having described this eco-prenurial discourse found in strategic practices, the following section provides details about environmental discourses found in estate management practices.

7.2.2 Environmental discourses found in estate management practices

Estate management practices found in the Firm include maintenance practices and waste treatment practices (cf. section 6.2.2). These practices reproduced performances such as water supplied to the factory and water treatment over time and changed incrementally at certain times. Stories about compliance with environmental regulations such as water abstraction license and water discharge licence were found compelling in estate management practices and shaped the development of these. For example, concerns over water treatment capacity identified changes at the water treatment plant (cf. section 6.2.2.2).

Seen this way, participants in estate management practices conceived and created change with particular emphasis on technical fixes such as a new water balance tank to improve water treatment capacity. Estate management practices conceived success as compliance with environmental regulation. Stories about compliance with environmental regulation were found to be shaped by concerns over the Firm's relationship with the local environment. For example, water sanitised in the water treatment plant was discharged in the local stream, and sludge consisting of organic rest products from water treatment was used as fertilisers on local farm land.

In addition to stories about compliance, estate management practices were found shaped by stories about efficiency. Efficiency gains were achieved through short term and technical fixes such as replacing existing water pumps with new and more efficient water pumps. Knowledge about efficiency gains was sourced from technology providers such as companies that make and supply water pumps. Stories about efficiency gains were found across many interlinked practices and identified short technical fixes to address energy consumption and water use in production practices (cf. section 6.2.2).

This environmental discourse found in estate management practices is labelled techno-centric. A summary of this environmental discourse is provided in table 7.4.

Table 7-4: Techno-centric

Logics	**Source of knowledge**	**Image of the natural environment**	**Image of the commercial context**	**Image of technology**	**Time horizon**
Techno-centric	Technology providers, consultants, regulators	Local surroundings such as local stream and local farm land	Harsh, competitive, short term	Engineering out problems; efficiency	Short term

This environmental discourse encompassed claims to knowledge that emphasised compliance with environmental regulation and efficiency. Concerns about environmental regulation and efficiency shaped new development through incremental type of changes. This environmental discourse legitimized many interlinked practices found in the Firm such as waste treatment practices and production practices and shaped the development of these over time. Having described this environmental discourse labelled techno-centric, the following section provides details about environmental discourses found in operational practices.

7.2.3 Environmental discourses found in operational practices

Operational practices found in the Firm are procurement, production and sales (cf. section 4.2.1 and 6.2.3). These practices produce performances such as buying vegetables, transforming these into pre-cut vegetables and distributing finished products to customers. These social practices are interlinked and shaped by relationships with customers on the one hand and suppliers on the other. Stories found in operational practices encompassed knowledge about (1) time, (2) product quality and (3) cost.

First, stories about time consist of knowledge about the shelf life of vegetables and images of freshness, which was found important in this commercial context (cf. section 4.1). Operational practices were therefore established in the Firm as to respond to customer demand (cf. 4.2.1). Performances produced in operational practices followed a short term cycle to complete production and distribution of finished products. This emphasis on time is illustrated by a quote by the Commercial Director:

"We are in a just-in-time business. We manufacture to order, we have just-in-time stock. Time is critical and also the fact that we are dealing with a natural product"

(Commercial Director, January 2010)

Second, stories about product quality consisted of knowledge about vegetables through many interlinked practices. For example, how vegetables supplied to the Firm are grown through to storage and production in the factory. Knowledge about product quality is well established in the Firm and shaped by food production protocols (cf. section 4.2). Concerns about product quality shaped social practices. Moreover, these food protocols (e.g. Field to

Fork and LEAF) identified environmental criteria such as pesticide used by growers that supply the Firm with vegetables.

Third, stories about cost found in operational practices encompassed particular reference to the cost of vegetables. Participants in operational practices conceived and created new developments in operational practices such as production to reduce the cost of product throughput. The image of success conceived in operational practices was to produce pre-cut vegetables at high quality and distribute these to customers. Seen this way, environmental performances such as water use and energy consumption are found necessary to complete operational practices. This environmental discourse is labelled operational. A summary of this environmental discourse is provided in table 7.5.

Table 7-5: Operational

Logics	**Source of knowledge**	**Image of the natural environment**	**Image of the commercial context**	**Image of technology**	**Time horizon**
Operational	Customers, suppliers, regulators	Accommodating expensive resources	Competitive: cost, quality and time	Efficiency	Short term

Operational running is a distinct environmental discourse found in operational practices. This environmental discourse shaped new developments in many social practices such as procurement, production and sales. For example, participants in production practices conceived and created new developments to improve water use (cf. section 5.2.13 and 6.2.3.2). Seen this way, this environmental discourse shaped new developments in the short term. Having described this environmental discourse labelled operational running, the following section provides details about environmental discourses found in sustainability practices.

7.2.4 Environmental discourses found in sustainability practices

Sustainability practices found in the Firm consisted of work to develop and implement a sustainability strategy (cf. section 6.2.4). This sustainability strategy developed at the Parent Group and affected social practices in the Firm. A stated aim of this strategy was to ensure business continuity in the longer term. Stories conceived in this sustainability strategy encompassed knowledge about natural resources that are distant in time and place. For example, growing populations and emerging economies are likely to affect access to natural resources, e.g. water and vegetables, which are important to the Firm.

Concerns about access to natural resources in the longer term affected the development of the Sustainability Strategy. Knowledge sourced in this sustainability practice derived from customers (e.g. M&S Plan A) and the FDF voluntary agreement. A key development in this sustainability practice was the Sustainability Strategy. This strategy provided guidance in the Firm. This environmental discourse is labelled sustainability. A summary of this environmental discourse is provided in table 7.6.

Table 7-6: Sustainability

Logics	Source of knowledge	Image of the natural environment	Image of the commercial context	Image of technology	Time horizon
Sustainability	Customers, voluntary agreement, media, university	Accommodating resources that are invaluable for business continuity; future resource availability	Global developments, future markets	Ensuring business continuity	Profitability, business continuity, long term

This sustainability discourse was a new discourse found in the Firm and shaped development of sustainability practices. This environmental discourse shaped new developments in estate management practices and operational practices in the Firm. In this way, this environmental discourse travelled in and through many interlinked practices.

7.3 Summary and Critical reflection

This section provides a summary and critical reflection of the environmental innovation journey conceptualised as social practices involving competing environmental discourses. First, a summary identifies the key findings in this chapter. Second, a critical reflection identifies the limitations in accounting for the environmental innovation journey in this way.

7.3.1 Summary

This discourse analysis revealed four distinct environmental discourse orders. These are (1) eco-prenurial, (2) techno-centric, (3) operational running and (4) sustainability. Details about these discursive orders are provided in table 7.7. This analysis of environmental discourses found in the Firm shows how various discursive orders are constructed and renders legitimacy to social practices.

Table 7-7: Environmental discourses found in the Firm (own development)

Discourse	Source of knowledge	Image of the natural environment	Image of the commercial context	Image of technology	Time Horizon
Eco-Preneurial	Market actors, university, consultants	Local, Strategic partner, romantic	Competitive, resource productivity, brand differentiation,	Symbolic value	Long term survival; future markets
Techno-centric	Technology providers, consultants, regulators	Local surroundings such as local stream and local farm land	Harsh, competitive, short term	Engineering out problems; efficiency	Short term
Operational	Customers, suppliers, regulators	Accommodating expensive resources	Competitive: cost, quality and time	Efficiency	Short term
Sustainability	Customers, voluntary agreement, media, university	Accommodating resources that are invaluable for business continuity; future resource availability	Global developments, future markets	Ensuring business continuity	Profitability, business continuity, long term

Environmental discourses are claims to knowledge that shape new developments in social practices to achieve superior environmental performances. This discourse analysis shows how knowledge about environmental problems and solutions are constructed in social practices and shape the development of these practices. Knowledge about environmental problems and solutions consist of stories that affect social practices in the Firm. However, discourses found in the Firm are not developing in a vacuum. Participants in the Firm drew on broader discourses, including environmental ones, found in society (cf. Dryzek, 2005), and develop story lines that create images of good environmental business in this sector.

In accounting for different environmental discourses in the Firm this study identified how storylines about good environmental business in this sector manifests (or not) in social practices in the Firm. Although these story lines found in the Firm draw on broader discourses in society, as detailed by Drycek (2005), this study has not explored the link to these. The following section provides a summary how environmental discourses developed in the Firm over time.

7.3.2 How environmental discourses developed in the Firm over time

In accounting for environmental discourses found in the Firm this insight shows that certain environmental discourses were dominant at particular times and shaped development of practices. An illustration of the environmental discourses at play in the Firm over time is provided in Figure 7.1.

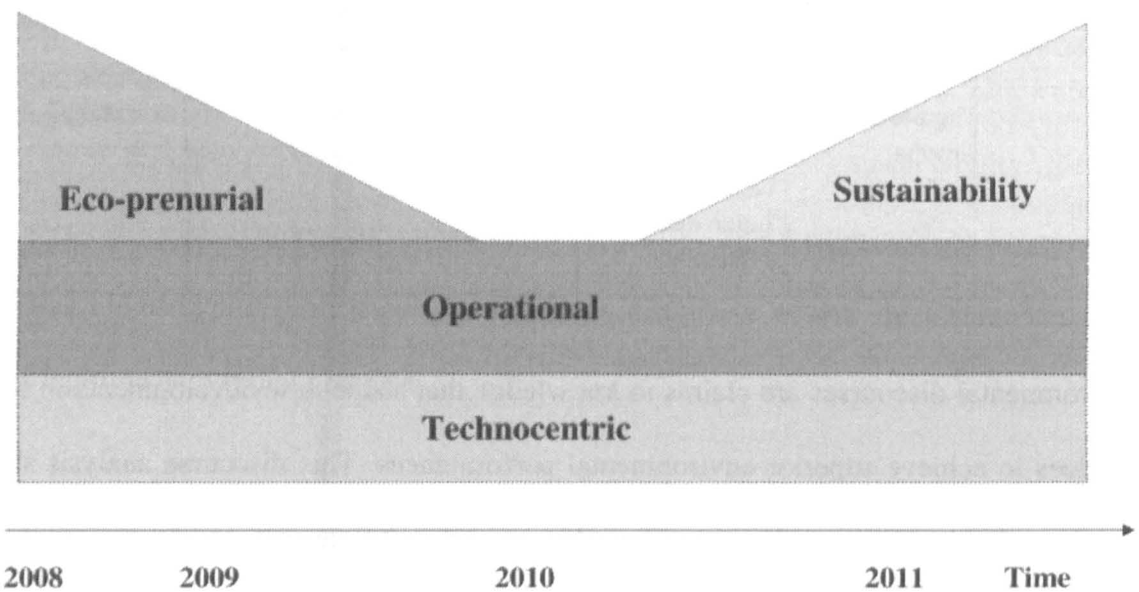

Figure 7-1: An illustration of environmental discourses at play in the Firm over time (own development)

As illustrated in Figure 7.1, many environmental discourses exist at the same time in the Firm. However, certain discourses are more dominant than others at certain times. By chasing through the different environmental discourses, this study shows the dynamic interplay of many discourses. The eco-prenurial discourse was found embedded in the Firm at the beginning of this study. Story lines found in this discursive order drew on broader discourses found in society. For example, the idea that customers in this sector emphasised premium products, e.g. organic food, was found relevant at that time. MD1 pursued a revenue based business model involving focus on resource productivity as well as adding value to the Firm's customers. The latter built on stories about superior environmental performances. This environmental discourse identified new developments that were found necessary to achieve business continuity in the longer term. However, this environmental discourse struggled against other social practices found in the Firm such as estate management practices and operational practices. Broader discourses in society changed as economic circumstances emphasised austerity measures in society. The eco-prenurial discourse was delegitimized.

As eco-prenurial discourse was phased out, an operational discourse became dominant. This discursive order was found persistent in the Firm over time. Story lines found in the operational discourse drew on broader ideas about resource productivity and efficiency. In similar vein, the techno-centric discourse was found to persist over time. This discursive order drew on ideas about compliance with environmental regulation. These two environmental discourses (operational and techno-centric) consisted of story lines that were made and remade, and affected changes in social practices. New developments involved incremental and short term technical fixes that changed social practices such as waste treatment.

The sustainability discourse emerged from the Parent Group and developed in parallel with existing discursive orders and practices found in the Firm. The sustainability discourse drew on ideas about resilience and commercial viability. These novel story lines were found pervasive and persuasive and manifested in the Firm's practices. This discourse order affected many inter-linked practices. For example, concerns about water use in the

Firm and among suppliers produced stories that conceived change in those social practices that involve water use. Seen this way procurement practices can change to secure a supply of vegetables in the longer term. Social practices that produce water use in the Firm such as production and estate management practices can change to secure water use in the longer term.

Seen this way, environmental discourses shape development of new practices, reproduce established practices, while delegitimizing those social practices that are no longer warranted. This analysis accounted for the environmental innovation journey using concepts of (1) social practices, and (2) environmental discourses to make sense of this process. Social practices are identified as the hardware that consists of participants working in conjunction with technologies to produce performances. Environmental discourses are identified as the software that shape new development in social practices. Environmental discourses consist of claims to knowledge about environmental problems and solutions that are produced in social practices that go beyond the Firm and shape social practices found in the Firm.

This discourse analysis de-centres participants in social practices as the prime movers of the environmental innovation journey and centres upon environmental discourses. A discourse analysis accounts for the political process of an environmental innovation journey. Environmental discourses are knowledge about environmental problems and solutions found in society and mobilised in social practices found in the Firm. In this way, environmental discourses are produced in social practices and shape their development.

7.3.2.1 Critical reflection on the role of the Researcher

The idea that the environmental innovation journey in the Firm involves a political process emerged in this study. This idea was identified by the Researcher via critical reflection of what went on in the Firm. For example, the event observed in January 2010 showed that people in the Firm have different visions of performances required. The MD1 prioritised the Environmental Strategy and initiated projects in light of this strategy, e.g. developing marketing performances to display environmental credentials. However, the legitimacy of these projects was challenged by other participants in the Firm (e.g. the Commercial Director and the Marketing Consultant). These different views were found important to account for. Theories of practice account for different visions to some extent. However, this practice approach do not account for why certain views are more pervasive and persuasive than others. This insight stimulated further research undertaken by the end of this study. Discourses were therefore not the focus of this study at the beginning of this study.

Concepts of environmental discourses and methods of discourse analysis changed the research perspective to account for discourses found in the Firm. In other words, the Researcher's perspective changed. This also changed the interpretation of the environmental innovation journey as one involving practices and competing environmental discourse. However, as this insight was produced at the end of research, discourses found in the Firm were based on data gathered via ethnographic methods without an explicit focus on discourses. This does not mean that this discourse analysis is invalid because this study focused on social processes and accounted for peoples' view. Importantly, peoples' view was interpreted by the Researcher. It was therefore found necessary to reflect on different discourse orders together with key participants in the Firm to achieve internal credibility.

7.3.3 Critical reflection

This chapter focused on an account of the environmental innovation journey conceptualised as social practices involving competing environmental discourses. Making sense of the environmental innovation journey in this way identifies how development of novelty unfolds through time and space. Participants in social practices enrol other participants and technologies to produce performances required to resolve environmental problems. In this process, participants work in collaboration with others and conceive and create new practices and change in established social practices. Environmental discourses that are produced in social practices beyond the Firm shape development of novelty in social practices found in the Firm.

This insight draws on the work by Dryzeck (2005) and the idea that environmental discourses exist in society and consist of knowledge about environmental problems and solutions. Environmental discourse orders that are persuasive and pervasive produce what can be described as 'good environmental business' and 'environmental protection' in social practices. In turn, social practices shape, to some extent, environmental discourses. Seen this way, the environmental innovation journey is not a linear process determined by distinct factors such as drivers that cause change in social practices. The environmental innovation journey is rather a non linear process shaped by multiple and competing environmental discourses.

This insight questions the idea that environmental innovation is a controllable process. In accounting for environmental innovation as a controllable process, human participants and social organizations are viewed as the prime movers in shaping an environmental innovation journey in a desired direction. However, this study shows that the environmental innovation journey consists of many participants beyond the traditional nexus of 'actors' that contribute to the nature and direction of environmental innovation.

In accounting for environmental innovation as change in social practices this study show that participants work in conjunction with technologies to produce performances. Changes in social practices were shaped by discursive orders found in social practices. Seen this way, those new developments posited by participants in social practices that accord with environmental discourses found in social practices proceed to implementation. However, new developments that were not found to accord with environmental discourses in social practices struggled to proceed to implementation.

8 Discussion and conclusion

This chapter provides an overall discussion and conclusion generated from the research in this thesis. The content of this chapter is:

8.1	**Introduction**	The introduction revisits the gap in knowledge this study set out to explore, the research perspective and method developed to achieve this.
8.2	**Discussion**	The research findings presented in chapters 5, 6 and 7 are discussed in light of the literature review presented in chapter 2.
8.3	**Critical reflection on research design application**	This section reflects on the approach to this study and research qualities in terms of credibility and transferability
8.4	**Conclusions and research recommendations**	This thesis provides a valid and useful approach to make sense of the environmental innovation journey and summarises the findings from exploring this process in a firm situated in the UK food and farming sector. Recommendations are provided for research to explore and account for an environmental innovation journey and for practitioners undertaking an environmental innovation journey

8.1 Introduction:

The introduction to this chapter revisits the gap in knowledge this study sought to address and then proceeds on to the research perspective and method developed in this study to explore the identified gap in knowledge.

8.1.1 Gap in knowledge

As was detailed in sections 1.1 and 2.4.1, the environmental innovation journey has received a growing interest in recent sustainability discussions. This concept builds on the idea that the emergence of innovations to improve, among other things, resource productivity, is situated in time and space and therefore unfolds dynamically through these. There is thus an interest in understanding how the environmental innovation journey unfolds inside a firm. However, this line of research is in its infancy involving but few studies (cf. section 2.4.1)

One approach draws on innovation management studies and offers an insight on the innovation journeys in firms (Van de Ven et al (1999). However, this insight does not say anything about the environmental innovation journey in a firm. Another approach focuses on the sustainable innovation journey and builds on the strategic niche management literature. Novelty emerges and is developed in protected niches, and proceeds through alignment to wider diffusion in society. A multi level perspective is developed in this literature and focus on transition to sustainable socio-technical system. However, this framework provides limited insight to what is going on inside firms as part of a transition.

This review of literature identifies a gap in knowledge of how we might understand an environmental innovation journey inside firms (cf. 2.4.2). Moreover, literature on environmental innovation in the UK food and farming sector with particular reference to food processing firms is limited. This insight led to the following research question identified at the beginning of this study:

- How does the environmental innovation journey unfold in a firm from the UK food and farming sector?

A relationship with a firm from this sector provided the researcher with an opportunity to explore the environmental innovation journey. A research perspective was developed in this study to address these two gaps in knowledge.

8.1.2 Research perspective developed to explore this gap in knowledge

A research perspective was developed in this study following constructivist commentators in social science (cf. section 2.4.3, 2.4.4 and 2.4.5). Drawing on literature in sustainable architecture, Guy and Shove (2000) challenge the utility of realist accounts. Among other things, they argue that realist accounts focus on a unilinear model in which process is conceived as progress towards predefined goals such as sustainability. The purpose of such realist accounts is to provide policy makers and planners with an understanding of how to promote best environmental practice and remove non technical barriers. However, realist accounts emphasise single theory and general application, which lack contextual sensitivity. In other words, realist accounts say very little about the actual processes that unfold in particular time and space contexts

Beveridge and Guy (2005) argue that environmental innovation is much more complex and messy than what realist and stylist accounts suggest. Among other things, the emphasis on key actors, such as a firm, overlooks the interaction and negotiation of many actors that goes on in particular contexts. Problems of unsustainability can therefore rather be thought of as a matter of local interpretation and are socially constructed (Guy and Moore, 2005; Fisher and Hajer, 1999)

This constructivist perspective offers an alternative approach to a realist account. Rather than trying to find a clearer definition of sustainability and build on a single theory to this end, this constructivist perspective is an invitation to explore how environmental innovation is made. This constructivist approach therefore emphases the need to understand what actually goes on inside a firm: how environmental innovation journeys unfold in particular time and space contexts. This study adopted a constructivist approach to explore an environmental innovation journey conceptualised as a social process. The social process refers to how environmental problems and solutions are constructed by the actors involved as they go along. The environmental innovation journey therefore consists of participants who interact and negotiate to develop something new to resolve environmental problems.

8.1.3 Method identified to explore an environmental innovation journey inside a firm

Following a constructivist perspective in social sciences, this study set out to explore an account of the environmental innovation journey inside a firm and generate new insights (cf. section 3.1). A pre-given framework or theory was not adopted to inform data collection and analysis. This follows Law (2004) who argues that reality is messy, and representations of reality that are less messy are therefore in danger of making a mess of trying to describe it. However, despite this constructivist critique, this does not mean that we cannot make sense of a social process such as an environmental innovation journey inside a firm without making a mess of it. A flexible research design was therefore developed in this study to explore the environmental innovation journey inside a firm following a constructivist perspective.

This flexible approach can be thought of as a progressive funnel. In this progressive funnel, data collection, insight from literature and data analysis developed simultaneously and stimulated further research throughout this study. This approach accords with Geertz (1963) who argues that pre-given frameworks are limited to stylist 'thin' descriptions and should usefully be replaced with 'thick' descriptions. An ethnographic case study involving methods such as participant observation and semi-structured interviews to collect data developed in this study to generate new insights. The principal advantage of this approach has been the opportunity it presents to explore how an environmental innovation journey actually unfolds. Data were analysed using a template approach in which analytical categories found in relevant literature contributed to sense making and generated new insights. The insights generated in this study are subsequently discussed in light of literature.

8.2 Discussion

In much of the literature, environmental innovation in general and the environmental innovation journey in particular, is rooted in a realist perspective in social sciences. Realist accounts of the environmental innovation journey focus on a unilinear model in which process is conceived as progress towards predefined goals such as sustainability (cf. Schot and Geels, 2008; Van de Ven et al., 1999).

Realist accounts therefore suggest that environmental problems can be solved through intervention by providing more information, incentives and sanctions, and thereby ''nudge' firms in desirable directions such as sustainability (Sunstein and Thaler, 2008). However, this builds on a number of assumptions such as rational choice, which is often at odds with actual social processes. Findings, presented in chapter 5, show that people in the Firm did not systematically identify environmental problems and searched for solutions subsequently in order to optimise their environmental performances. Instead, people in the Firm identified environmental problems and solutions as they went along.

This insight is in accord with Beveridge and Guy (2005), who argue that reality is much more messy and complex than stylist accounts suggest. Findings from this ethnographic case study demonstrate the validity of this constructivist critique of realist accounts. Chapter 5 identified an account of the environmental innovation journey that did not concur with the unilinear model. The latter perceives process as one involving progress from plan to implementation to achieve predefined goals such as sustainability. Realist accounts therefore emphasis the pursuit of drivers and avoidance of barriers identified necessary to complete this process. The understanding of the environmental innovation journey rooted in realist perspective is thus one that involves 'moves' from one stage to another towards identified objectives (cf. Van de Ven et al., 1999). However, findings from this ethnographic case study did not accord with realist accounts because these are too stylised.

This study rather identified an account of the environmental innovation journey that is much more messy and complex than suggested by stylist accounts. Environmental innovations identified by actors in the Firm did not proceed easily from plan to implementation. In contrast, environmental problems and solutions were rather found to be multiple involving many actors beyond the traditional nexus of a firm. For example, in this study, many actors were accounted for such as managers, consultants, suppliers and customers. Moreover, technologies were identified that affect the environmental innovation journey. It was therefore found useful to abandon traditional stylist accounts in trying to make sense of this process because isolating distinct factors such as drivers, barriers and key individuals did not help to make sense of this process.

The environmental innovation journey was rather found characterised as a multiple, contingent and fluid process. This refers to the multiple trajectories found in the Firm involving many actors and the construction of different environmental problems and solutions that unfolds through time and space. Thus, rather than a unilinear model, this study has identified a situated, non-linear and fluid process involving temporary fixes that are reversible. This thick description, presented in chapter 5, accounts for the context in which the environmental innovation journey actually unfolds. However, this crude representation of the environmental innovation journey involving a focus on the social construction of environmental problems and solutions does not help to make sense of this process.

Following Beveridge and Guy (2005), it can be useful to try making sense of how the environmental innovation journey actually unfolds. This study shows that people in the Firm do things as they go along in conjunction with technologies to produce performances. In other words, environmental innovations are made. Practice theory was identified in literature to aid sense making of this process (Shove and Walker, 2010; Pantzar and Shove, 2010).

Following Law (2004), making sense involves a process of developing a representation of reality that does not make a mess of describing it. Practice theory offered an alternative framework to stylistic approaches to account for how environmental innovation unfolds through time and space: environmental innovation journeys. In this way, the environmental innovation journey is a social process and is conceptualised as social practices. Environmental innovation consists of individuals working together to conceive and create new practices and change existing ones, in relation to their imaginings of environmental problems and performance required to resolve these.

The environmental innovation journey conceptualised as social practices makes sense of what actually goes on inside a firm. This practice theory of innovation accounts for many actors working in conjunction with technologies to produce performances in different practices. This practice framework inspired by literature usefully accords with the multiple, contingent and fluid nature of the environmental innovation journey identified in this study. The environmental innovation journey, seen in this way, shows how practices are developed, reproduced and deleted through time. This insight stimulated further research in trying to make sense of why new practices are developed, while other practices are reproduced, refined or deleted through time and space.

Realist accounts identify factors as distinct drivers such as information, incentives and sanctions to understand progress towards predefined goals. However, in this study it was not found useful to identify and isolate distinct factors reduced to cause-and-effect narrative. Instead, this study identified non-linear causality and found that competing environmental discourses shape social practices. In other words, people in the firm do things as they go along, which is captured as practices. Considering that people do things for a reason this study follows Foucalt (1968): 'what is the reason at work?'

Beveridge and Guy (2005) argue that (environmental) *"innovation is something that is 'constructed', enabled and made real through constant negotiation in specific contexts"* (2005:674). Seen this way, environmental innovation journeys are shaped by interaction and negotiation between many actors involving their competing interests and visions. The latter can usefully be thought of as environmental discourses. The literature on environmental discourses identifies the importance of discourse strategies to resolve environmental problems through innovation (Hajer, 1995).

Hajer (1995) follows Foucault (1976; and 1975) and defined environmental discourse as *a specific ensemble of idea, concepts and categorisation that are produced, reproduced and transformed in a particular set of practices through which meaning is given to social and physical realities"* (Hajer, 1995:44). In this view, environmental discourses involve multiple and sometimes competing claims to knowledge mobilised in practices and hold the potential to shape practices. However, those that are persuasive and pervasive are legitimised and therefore powerful to shape practices, while those that are not are delegitimized.

This insight draws on Dryzeck (2005) and the idea that broad environmental discourses exist in society involving reference to 'good environmental business' and 'environmental protection'. These ideas of 'good environmental business' are pervasive in society, but are rather mobilized in firm practices by those actors involved through persuasive stories which change (or not) social practices. However, causal relationships between environmental discourses and social practices are not linear. Social practices are shaped by (environmental) discourses, which are mobilised and therefore shaped to some extent by social practices.

The environmental innovation journey is a social process, conceptualised as social practices involving competing environmental discourses. Environmental innovation comprises social practices in which environmental problems and solutions are constructed.

In making sense of the environmental innovation journey, social practices are thought of as the hardware of participants working in conjunction with technologies to produce performances. A discourse analysis of environmental innovation conceptualized in this way therefore shows how environmental problems, solutions and a related set of subjects and objects (people and things) are produced in and through practices and legitimized Environmental discourses are the software that 'exist' among these practices and produces them through time. Those environmental discourses that are socially accepted (persuasive and pervasive) legitimise development of new practices and change in other practices and delegitimize new developments that do not accord with the environmental discourses found in social practices.

This study has provided an account of an environmental innovation journey inside a firm from the UK food and farming sector. The environmental innovation journey is a social process and can usefully be conceptualised as social practices involving competing environmental discourses. This way of making sense of the environmental innovation journey provides a valid contribution to this line of research and can aid others such as researchers and practitioners to make sense of it in different contexts (cf. section 8.5).

Having discussed the insights generated in this study, the following section will revisit the research aim and objectives.

8.2.1 Satisfying research aim and objectives

This study identified the following research question at the beginning of this study:

- How does the environmental innovation journey unfold in a firm from the UK food and farming sector?

Considering that little is known about this process in firms, this study adopted a research perspective rather than a theory. This perspective followed constructivist commentators in social sciences (Beveridge and Guy, 2005; Oak, 2010; and Hajer, 1995). In this perspective, the environmental innovation journey is conceptualised as a social process. To account for this process the following research objectives were identified at an early stage of this study:

1. To identify and critically reflect on theories of environmental innovation with specific reference to the environmental innovation journey conceptualised as a social process.

2. To identify and critically reflect on environmental innovation in the UK food and farming sector.

Research objectives 1 and 2 were addressed in the literature review in chapter 2. A critical reflection of this literature identified two gaps in knowledge and led to research objective 3.

3. To identify and critically reflect on the environmental innovation journey conceptualised as a social process involving the construction of environmental problems and solutions.

Research objective 3 drew on constructivist commentators in social sciences and inspired the development of an interpretive framework to account for the environmental innovation journey conceptualised as a social process. This framework guided initial data collection and analysis detailed in chapter 5. This analysis showed that the environmental innovation journey is messy and complex as these are (1) non-linear, (2) ongoing, (3) multiple, and (4) reversible.

This insight stimulated further research, which identified environmental innovation conceptualised as social practices. This conception is rooted in constructivist perspectives and accord with the characteristics of the environmental innovation journey observed in the Firm. Moreover, research that draw on theories of practice to account for environmental innovation is in its infancy and needed exploring. This insight led to research objective 4.

4. To identify and critically reflect on the environmental innovation journey conceptualised as social practices.

Research objective 4 is met in chapter 6. This analysis shows how we can make sense of the environmental innovation journey conceptualised as social practices. People in the Firm do things in conjunction with technologies and in relation to their images of performances required of practices. An interpretive framework was developed to make sense of this process. Seen this way, innovation is viewed as changes in the elements of practices; these elements were categorised as people, images and technologies.

The environmental innovation journey unfolds through practices, which includes four distinct processes; these are: (1) new practices can emerge, (2) practices can persist; (3) practices can disappear, and (4) a change in one practice can affect other practices. However, while this analysis shows how practices unfolded in the Firm over time, it did not account for what shape practices.

In theories of practice, people are the carriers of practice in terms of what they do. People do things for a reason. This insight stimulated further research to account for those reasons at play, and led to research objective 5.

5. To identify and critically reflect on the environmental innovation journey conceptualised as social practices involving competing environmental discourses.

The environmental innovation journey consists of practices, which are shaped by competing environmental discourses as detailed in chapter 7. This way of making sense of the environmental innovation journey was found valid and useful. It is valid because it accords with observations in the Firm. Hence, this analysis offers an approach to make sense of the environmental innovation journey without making a mess accounting for it. This approach is useful because it can be transferred to other contexts.

This study has completed exploratory research and addressed two gaps in knowledge. More specifically, these are: (1) how the environmental innovation journey unfolds in a firm from the UK food and farming sector, and (2) identified a way to account for this process. However, this research design and application is not without limitation.

8.3 Critical reflection on research design and application

This section provides a critical reflection on the research design and its application in this study. The methods adopted in this study followed a flexible research design to explore an account of an environmental innovation journey in a firm from the UK food and farming sector. The approach to data collection was an ethnographic case study involving participant observation and semi-structured interviews. A template approach was developed to analyse data. This flexible design adopted in this study is not without criticism or challenges.

This critical reflection on the research design and its application in this study is structured in two subsections. First, the realist critique of constructivist research approaches and challenges encountered in this study. Second, the assurance of research quality involves reference to the creditability and transferability of this study.

8.3.1 Realist critique of, and challenges encountered in this study following a flexible design

Research rooted in traditional social sciences typically involves fixed and quantitative research strategies such as experiments and surveys (Anastas and MacDonald, 1994). In broad terms, the researcher is informed by literature and identifies a theory in advance that guides data collection. Data collected in this way is analysed subsequently using a standardised methods. The principal focus is to identify the underlying mechanisms of social process and identify what factors that shape the phenomenon studied.

The task is to discover theories to explain the phenomenon studied and test theories subsequently to refine these. The underlying idea in realist account is that phenomena can be explained by structures and mechanisms, which can be identified through research. The outcome is knowledge that can be transferred to other contexts and which is therefore generalizable. The quality of fixed research design is validated as to assure reliability. This can be achieved by replicating a study.

The principal critique of constructivist approach involving flexible research designs is therefore the role of the researcher and the lack of standardised means to assure validity and reliability of the study results. In fixed design, the researcher is separated from the phenomenon studied in order to avoid contamination of research results. However, in understanding a situation involving people in the real world usefully requires insight to their meanings and experiences. This insight can only be achieved through participation with those people experiencing the reality (Manis and Meltzer, 1967). Here, reality is not what is discovered, but rather what is experienced by participants.

The presence of the researcher and interaction with other participants in the social setting is therefore necessary to generate new insights. However, to acquire sufficient insight to a particular social setting often requires lengthy studies. To achieve good insight and understanding of the phenomenon studied, this study used ethnographic methods to collect data. This ethnographic approach is therefore constrained by (1) the time available to complete a PhD study, and (2) the actual observations practically possible.

Data collection in a flexible research design puts emphasis on the research-as-instrument rather than relying on prescribed research procedures involving tight formulae, tools and instruments (Chesney, 2001). Data collected using ethnographic methods, e.g. participant observation and semi-structured interviews, involves concerns about research biases and respondent biases (Lincon and Guba, 1985), which can generate misleading interpretation from research following flexible design.

Respondent biases refer to the other participants in the social setting. This can for example involve people that withhold information that may be necessary for the researcher to complete the study. Respondent biases can also refer to those respondents that try to please the researcher by saying or doing what he or she thinks the researcher wants to see. In trying to avoid respondent biases in this study, mixed methods for data collection were usefully applied. Interviews were applied to acquire individual accounts from people involved in this study with particular reference to what they have to say around a selected topic. Participant observation complemented such accounts as this method enables the researcher to observe what other participants say and do.

Doing research in the real world means that the researcher has very little control over the phenomenon studied. The researcher cannot, for example, decide what information other participants should give in order to complete the study. In contrast, the researcher can prompt other participants to generate a reaction. Information is acquired from other participants and is a matter of building trust with other participants. It is therefore necessary to become a trustworthy member of the social setting.

In this study, the relationship with the Firm and with other participants changed over time. This means that new relationships were created as the study proceeded. The focus of this study was not involving sensitive information that could harm the Firm or the people involved. In this study, withholding information was not an issue to complete the study. This study is rather a reflection of the researcher's experience, and thus interpretation of the environmental innovation journey. Time spent in the Firm and interaction with participants was therefore critical to achieve this.

Researcher biases can be a threat to studies that following flexible design and rely on the researcher as instrument to collect and analyse data. Researcher biases refers to the danger of preconceptions about the situation prior to data collection and analysis, which can mislead the researcher to make certain decisions such as selecting key informants and what to observe. In this study, the purpose was to explore the environmental innovation journey. The researcher engaged with other participants in the Firm and reflected on what was going on in there. However, the researcher cannot be everywhere and see everything. Hence, this study is based on what could be observed. This study is based on the researcher's subjective experience: interpretation and representation from case study.

Having identified the critique of flexible design and the challenges encountered in this research approach, the following section identifies research qualities. In Lincon and Guba (1985) research qualities in studies that follow flexible design are different from those that follow a fixed design. Instead of focusing on issues of reliability and generalizability, qualities in flexible design are more concerned with creditability, trustworthiness and transferability.

8.3.2 Research qualities

This section identifies the research qualities of studies following a flexible design. The quality criteria are credibility, trustworthiness, and transferability. First, credibility refers to the idea that research can produce more or less convincing accounts, that it provides a representation from a case study that make sense without making a mess describing it. However, achieving credibility is not only a responsibility of the researcher, but involves the reader as well. The reader may choose not to believe in the story provided by the researcher. Second, trustworthiness is therefore important to emphasise in studies that follow a flexible design. Trust can be established by demonstrating the research process in an open and transparent way. Third, transferability refers to the outcome of the study and whether the insight produced in one context may be applied in other contexts. These three criteria are discussed subsequently.

Credibility is achieved in flexible research design if the arguments it presents are convincing and trustworthy. There are different strategies that can be applied in flexible research design to ensure trustworthiness and deal with reactivity, researcher bias and respondent bias. Following Padgett (1988) some of these strategies are prolonged involvement, triangulation and audit trail. Prolonged involvement refers to those studies in which the researcher spends considerable time in the social setting. Triangulation involves the use of more than one method of data collection to cross reference findings. Here, multiple sources of information are used to enhance the rigour of the research. However, triangulation was not found useful because it is problematic to compare data collected using different methods. Audit trail, involves an attempt to keep a record of the researcher's activities throughout the study.

In this study, a combination of prolonged involvement and audit trail was adopted. The Researcher developed an intimate account of the environmental innovation journey based on actual observation in the Firm. These observations were made during frequent visits in the Firm as described in section 5.3.1.4. A reflective diary was adopted to record the Researcher's activities through this study. This reflective diary produced an audit trail, which reflects times in the Firm when particular environmental problems were identified and solutions were pursued. These two approaches were adopted so as to avoid issues of reactivity, researcher biases and respondent biases.

A reflective diary was kept in which not only what was observed was accounted for but also the researchers involvement in activities in the Firm. Hence, the diary reflects on the researcher's experience from the field and interaction with other participants and their activities in which the researcher took part. The time spent in the Firm and mixed method was useful to avoid respondent biases. Critical reflection involving inputs from supervisors' conceptual frameworks and other participants in the Firm was useful to avoid researcher biases.

The outcome of this study is transferable if others find it credible. Greenwood and Levin (2007) make a distinction between internal and external credibility. Internal credibility concerns the trustworthiness of the study among the participants and how well they believe in the outcome of the study. Internal credibility was achieved throughout the study via open discussions regarding research scope and findings with other participants in the Firm. Research findings were presented to selected representatives in the Firm to receive their view on the outcome of the study.

Internal credibility was achieved through meetings with key participants in the Firm. The purpose of these meetings was to reflect on research insights together with these participants. The focus in these meetings changed during the course of this study because key participants in the Firm changed as well as the nature and direction of the environmental innovation journey. More specifically, relationships with three groups of key participants were developed in this study. These were (1) the Steering Group for the Environmental Strategy (June 2009 to December 2009), (2) the Environmental Management Group (April 2010 to October 2010), and (3) the Sustainability Group (October 2010 to October 2011). Each group and meeting procedure involving feedback from key participants is discussed subsequently.

The Steering Group for the Environmental Strategy was formed in June 2009. The Managing Director 1 was leading this group and invited the Factory Manager (FM1), Sales

Director, the Researcher and Supervisor 1 to participate. This group was formed in collaboration with the Researcher, Supervisor 1 and MD1 to reflect on the development and implementation of the Environmental Strategy in light of the insight produced from this study. Hence, findings from research were presented to this group and reflected upon. These meetings were therefore important for data collection. Four meetings were held with this group between June 2009 and December 2009. This group stopped to exist after that the Environmental Strategy was abandoned and the MD1, FM1 and Sales Director left the Firm.

The Environmental Management Group was formed in April 2010. This group was led by Factory Manager 2 and involved the Environmental Office and the Researcher. This group met on a weekly basis during the period April 2010 to October 2010. The interim Managing Director (MD2) was invited to key meetings. For example, a meeting was held at the University in May 2010. The Researcher presented key findings from initial research. The participants from the Firm took part in a discussion to reflect on these findings. This led to development of an environmental management workshop held in the Firm in June 2010 (Please see Appendix C). This group changed following the development of the Sustainability strategy at the Parent Group. Key participants, e.g. MD2 left the Firm, the Sustainability Director became a new key participant and the Researcher's relationship with the Firm changed. The Researcher visited the Firm less frequently (once a month) following this event.

The Sustainability Group was formed in August 2011 and was led by the Sustainability Director. This person invited the Researcher and the Environmental Officer from the Firm to participate in the development of a Sustainability Strategy. Work on this strategy involved meetings with Key participants e.g. Sustainability Director as well as participants from other divisions of the Parent Group. These meetings provided moments for critical reflection and feed back from key participants in the Firm such as Sustainability Director and Factory Manager 2. For example, a meeting was held with the Sustainability Director at the University. Key findings from research undertaken by the Researcher were presented and reflected upon in this meeting. This group, led by the Sustainability Director, continued to exist in the Firm, however, after October 2011, without the Researcher.

External credibility, on the other hand, involves people that have not participated in the study. The specific research findings produced in this ethnographic case study are context dependent and can therefore not be transferred to other contexts. However, the research perspective and how to make sense of an environmental innovation journey can usefully apply to other contexts. The approach and method could therefore be transferred to other situations.

Having provided a critical reflection on the research design applied in this study and the research qualities, conclusions drawn from this thesis is provided subsequently.

8.4 Conclusions

This section provides the conclusions of this thesis and the contribution to knowledge. The conclusions and contribution to knowledge are essentially threefold:

- There is a valid constructivist critique of a realist account to understand an environmental innovation journey;

- Following a constructivist perspective, we can make sense of an environmental innovation journey conceptualised as social practices involving competing environmental discourses;
- Insights generated in this study can aid others to make sense of an environmental innovation journey in different contexts

8.4.1 Constructivist perspective is valid and useful to explore an environmental innovation journey

This study demonstrates the validity of the constructivist critique of realist accounts to understand an environmental innovation journey inside firms. Among other things, realist accounts perceive process as involving a unilinear progress towards predefined goals such as sustainability (cf. Schot and Geels, 2008). Moss et al (2005) frame this concern with realist accounts by focusing on the gap between political ambition of sustainability and actual behaviour in society. Political ambition to achieve sustainability often consists of work to define sustainability and move society towards that goal by acting upon this process.

The role of policy makers and planners is to remove non-technical barriers involving knowledge, incentives and sanctions to address environmental problems. However, as noted by Castree (2005) and Hajer (1995) knowledge about environmental problems shifts across time and place. This insight questions realist accounts as these lack contextual sensibility and replaces actual processes with an assumed understanding of process. For example, the actual process inside firms associated with decision making is black boxed and replaced with ideas about rational behaviour.

Following constructivist commentators in social sciences, this study explored the environmental innovation journey in the Firm using ethnographic methods. This insight, presented in chapter 5, shows that the environmental innovation journey is an ongoing process with fluid, contingent and multiple characteristics:

- Multiplicity: The environmental innovation journey consist of **multiple trajectories**: here trajectory refers to novel ideas posited in the Firm. Many participants affected the development and implementation of novel ideas in the Firm. These ideas were multiple, diverse and shifted over time
- Contingent: the environmental innovation journey process is found contingent upon many participants but also technologies found in the Firm.
- Fluid: in studying the environmental innovation journey as it unfolds over time, this insight identifies the fluid nature of this process. The development of novelties in the Firm is an ongoing process involving temporary fixes that are reversible. This fluid nature stands in contrast to traditional accounts of environmental innovation such as a shift from one steady state to another (cf. Schot and Geels, 2008).

This study shows that reality is much more complex and messy than realist accounts suggest. The utility of realist 'thin' abstraction and neat accounts can therefore involve a danger of making a mess rather than aiding sense making. Preconceptions about key individuals such as senior management buy-in and assumptions of rational behaviour of firms are at odds with actual behaviour. This insight questions assumptions about the role of key actors such as senior managers inside firms and policy makers in society to steer progress in a predefined direction. An innovation is therefore not a process that proceeds easily from plan to implementation, but unfolds through time and space. For example, solving a specific environmental problem may lead to other environmental problems and so on in what can be described as an ongoing process.

In accounting for an environmental innovation journey this study found a valid approach to make sense of this process. Following constructivist perspectives, the environmental innovation journey is usefully conceptualised as social practices involving competing environmental discourses.

8.4.2 Making sense of an environmental innovation journey

This study found a valid approach to make sense of how an environmental innovation journey unfolds through time and space.

First, following constructivist commentators in social sciences, this study identifies environmental innovation as a social process that involves interaction and negotiation between participants to create something to resolve environmental problems. Environmental problems and solutions are therefore socially constructed. The environmental innovation journey is an ongoing process involving temporary fixes that are reversible.

Second, drawing on practice theory of innovation, the concept of practices is usefully identified as the unit of analysis to account for the environmental innovation journey. An analysis of social practices accounts for the contribution of many participants beyond the traditional nexus of key actors such as senior management. Rather than assuming the role of key actors such as managing directors as essential to the success or failure of an innovation (emergence of novelty), many participants are accounted for. Social practices as the unit of analysis identifies for the main participants, e.g. those who produce performances. Moreover, technologies are accounted for: participants work in conjunction with technologies to produce performances. In this way, technologies affect social practices and are not separated in the analysis.

Third, in accounting for the environmental innovation journey, conceptualised as social practices, this insight shows how new practices are developed, how easily practices are reproduced and deleted through time. People work together to conceive and create new practices and change existing ones in relation to their imaginings of environmental problems and performance required to resolve these. Seen this way, environmental problems and solutions are constructed in social practices. A discourse analysis of environmental innovation conceptualized in this way therefore shows how environmental problems, solutions and a related set of subjects and objects (people and things) are produced in and through practices and are legitimized.

The discourse analysis identifies the story lines that shape and are shaped by social practices found in the Firm. Participants in the Firm draw on broader discourses, including environmental ones, in society. Dryzeck (2005) identifies broader environmental discourses in society (cf. chapter 7.1.3). Although this study did not explore the link between broader discourses and local stories, it was noted that local story lines come from society. Figure 8.1 illustrates how social practices and discourses in society are interlinked.

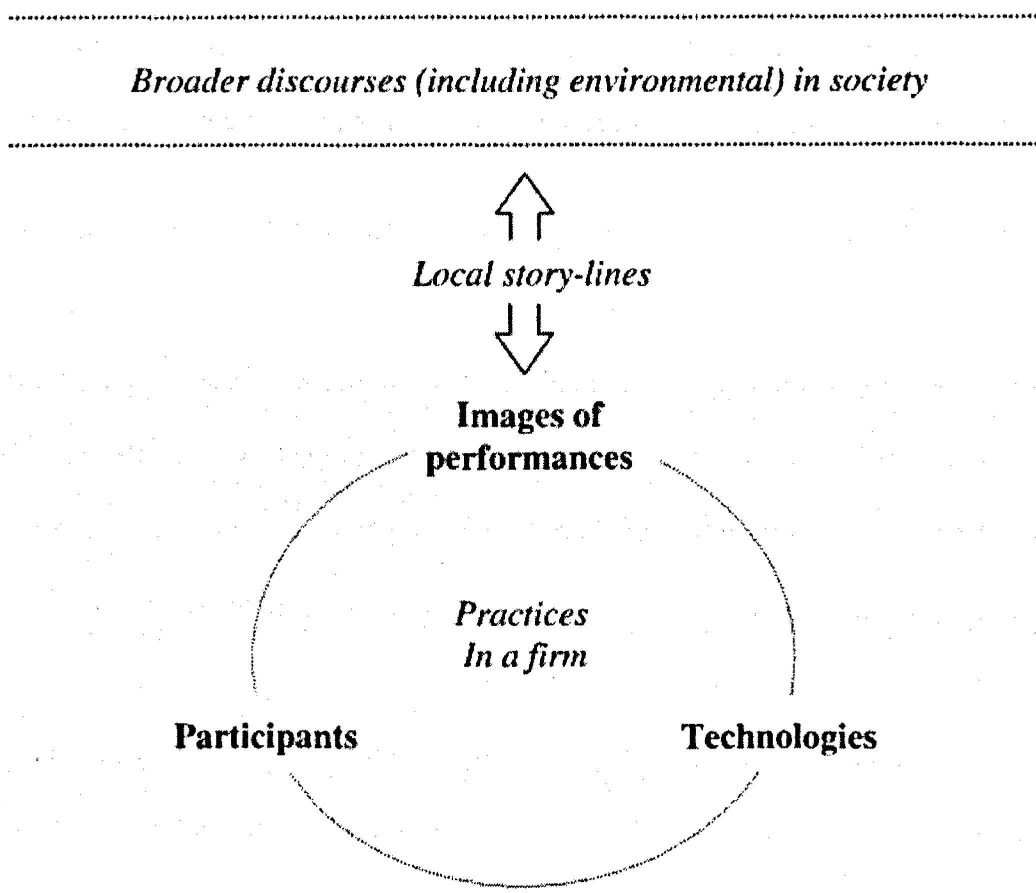

Figure 8-1: Making sense of the environmental innovation journey (own development)

This study focused on the local story lines and how these materialise as images of performances in the Firm's social practices and shape development of these. However, social practices in the Firm affect local practices: certain story lines are pervasive and persuasive, while others are not.

Exploring the environmental innovation journey as a social process conceptualised as social practices involving competing environmental discourses offers a valid approach to understand and make sense of this process. This approach could lend itself usefully to explore and account for an environmental innovation journey in other contexts. The utility of this approach is discussed in research recommendations provided subsequently.

8.4.3 Conclusions from exploring the environmental innovation journey in a firm from the UK food and farming sector

This section provides the conclusions from exploring the environmental innovation journey in a firm situated in the UK food and farming sector. The concluding remarks identify the utility of this approach described in section 8.4.2. This study shows that practitioners who wish to improve environmental performances in a firm can identify broader discourses in society and create story lines that make sense to the social practices in the firm.

Story lines consist of meaning that provides the rationale to develop something new to resolve environmental problems in a firm. These story lines draw on broader discourses in society and shape the images of performances required in the firm's practices. These story lines must usefully appeal to social practices found in the firm. Hence, social practices co-construct story lines in light of broader discourses in society.

It is therefore important to have knowledge about the firm in which novelty is to be developed. Story lines about 'good environmental business' need to make sense to the firm. Those story lines that make sense are more likely to become socially accepted and appeal to the local discursive order found in the firm. Story lines that are socially accepted and appeal to images of performances found in a firm's social practices are therefore holding a potential to legitimise the development of novelty. Story lines that do not make sense are more likely to become delegitimized.

This study showed that the story lines developed by the Group Sustainability Champion in collaboration with other participants in the Firm made sense to the case study Firm (cf.

chapter 7.2.4). These story lines were pervasive and persuasive and legitimised development of novelty in the case study Firm.

The discursive order labelled 'Sustainability' in the case study Firm drew on discourses found in the UK retail sector involving reference to M&S's Plan A and the voluntary agreement developed by the Food and Drink Federation. These story lines are compliance plus and go beyond environmental regulations found in the food processing sector. Moreover, the story lines identified business resilience as a rationale to work on the Sustainability Strategy.

8.5 Research implications

The insights generated in this study offer a valid approach to make sense of an environmental innovation journey that can aid others to make sense of this process in different contexts. The implications identified in this study are essentially twofold. First, research implications encountered in exploring an environmental innovation journey refers to method and research perspective to generate new insights into a context that is poorly understood. Second, implications for policy makers, planners and practitioners consist of method and perspective to conceive and create new social practices and change in existing ones.

8.5.1 Research implications in exploring an environmental innovation journey

Research to explore an environmental innovation journey is usefully undertaken with the researcher(s) as participants. In this way, the researcher(s) are positioned as insiders. This is necessary to generate new insight and to account for social practices and competing environmental discourses that are context specific. This insider approach stands in stark contrast to studies undertaken as 'outsiders looking in'. The researcher positioned outside social practices cannot account for the dynamics involved. For example, interviewing is limited to individual accounts, e.g. key informants, and their view of environmental innovation.

There is thus a danger of relying on interviewing for data collection. Participant observation (PO) is therefore a useful complement to interviewing (cf. section 3.1.3). PO lends itself usefully to observe actual processes that unfold through time and space. This study shows that 'researcher as insider' is needed to understand an environmental innovation journey. The researcher as insider and participant has essentially two advantages. First, it enables the researcher to see how an environmental innovation journey, conceptualised as social practices actually unfolds through time and space. Second, it does not replace actual processes with assumptions about a phenomenon such as the role of key individuals, agency and rational choice.

Ethnographic methods, such as PO and semi-structured interviews, are therefore recommended to explore an environmental innovation journey in a context that is poorly understood by the researcher. The research approach can usefully be designed as follows:

- **Ethnographic case study** as a research method involves an approach in which the researcher engages as 'insider' and as a participant of an environmental innovation journey. However, this requires good access to a firm or other social setting/context which the researcher wishes to explore and generate new insights.
- **Data collection** can usefully involve participant observation and semi-structured interviews. These techniques to collect data provide opportunities to interact with people in social settings and generate insights into how environmental problems and solutions are constructed.

- **Semi-structured interviews**: Researcher(s) that are new to a social context can usefully pursue a round of semi-structured interviews with key-informants early in the study. The advantage of doing interviews early is the opportunity it presents to get to know other participants in the organisation and gain insight to their view on environmental problems and solutions. In this way, findings from interviews can be followed up and facilitate further interviewing.
- **Participant Observation**: Researcher(s) that are new to a social context can usefully become a trustworthy member through participation in work undertaken by the organization. However, it is important to avoid responsibility for the success of the organization and draw a distinction between doing work *for*, and doing work *with*, the organisation. The latter implies participation without responsibility. Research activities involving PO can be structured in a work schedule developed with the organisation: what is the organization hoping to achieve with this project and how can the researcher(s) facilitate this (see also section 8.5.1).

- **Data analysis**: data can usefully be analysed using a template approach involving analytical concepts found in literature. These analytical concepts are flexible. In this study it was found useful to draw on practice theory and concepts of environmental discourses to make sense of data. However, these categories can change as necessary to aid sense making. For example, different discourse categories may apply to different contexts.

- **The progressive funnel** approach is useful to make sense of a complex situation by providing a representation. In broad terms, the research collects and analyses data in light of literature to make sense to generate insight, which stimulates (or not) further research.

In accounting for an environmental innovation journey, this study suggests a constructivist perspective and not a theory. Seen this way, the environmental innovation journey is a social process, conceptualised as social practices involving competing environmental discourses. The main concepts used in this study are:

- **Social process**: environmental problems and solutions are socially constructed. In this social process, people interact and negotiate to create something to resolve environmental problems.
- **Social practice**: people work in conjunction with technologies to produce performances in relation to their imaginings of environmental problems and performance required to resolve these
- **Environmental discourses**: a discourse analysis of environmental innovation conceptualized as social practices shows how environmental problems, solutions and a related set of subjects and objects (people and things) are produced in and through practices and legitimized.

This section has discussed implications for research to explore environmental innovation journeys. It is suggested that research should be undertaken with the researcher-as-insider using ethnographic methods (cf. chapter 3.1.2). This is crucial because knowledge about the context matters to make sense of an environmental innovation journey. In this approach, the researcher usefully interacts with practitioners such as a firm, policy making and planning. Implications for practitioners, provided subsequently, are different that to researchers. This is because practitioners, e.g. participants in a firm, policy makers and planners, have considerable knowledge about, and responsibilities for, their context.

8.5.2 Implications for practitioners of environmental innovation journeys

This section discusses implications for practitioners, e.g. a firm, policy makers and planners, participating in an environmental innovation journey. Practitioners have knowledge about the specific context and therefore insight to options and constraints of environmental innovation. Here, options are images of performances, e.g. superior environmental performances, and solutions identified to achieve this. Constraints are identified as 'elements', e.g. technologies, missing in social practices and therefore required as to achieve desired performances.

The perspective developed in this study lends itself usefully to make sense of the environmental innovation journey as one involving multiple pathways. Drawing on knowledge about the situation at hand, participants of an environmental innovation journey can identify multiple pathways to sustainable futures. This requires a flexible approach, which stands in large contrast to traditional planning and implementation 'models' found in the innovation literature (cf. Tidd et al., 2005). In this flexible approach participants identify environmental problems and solutions that are meaningful to the situation at hand.

In accounting for many participants contributing to the environmental innovation journey, this study replaces the agency of key actors and identifies competing environmental discourses. Environmental discourses were analysed to identify specific discursive orders that shape the nature and direction of the environmental innovation journey. In this way, discursive orders can be thought of as a frame that structures capacity for action in social practices. Changes in social practices that accord with environmental discourses are likely to proceed.

Practitioners with knowledge about the context can therefore usefully draw on the perspective developed in this study to act in light of their own sense making. In this way, policy makers and planners are not seen as agents that act upon an innovation process, but rather as participants. These key participants can facilitate the nature and direction of an environmental innovation journey. Methods that can facilitate change in social practices are Action Research (AR). In broad terms, AR is a method that follows a cyclic process. Following Bassey (1998), AR consists of the following interrelated activities:

1. Identifying (environmental) problems and solutions, and desired performances
2. Implement solutions,
3. Follow up solutions and,
4. Make adjustments as necessary in response to changes in the context.

In this approach, practitioners can bring the main participants together, e.g. using a search conference (cf. Greenwood and Levin, 2007) and identify the environmental problems and solutions at hand. In this way, participants draw on the knowledge found in social practices and can come to an agreement on actions that are meaningful to them. Implementing solutions to environmental problems is specific to the situation at hand. However, it is necessary to follow up action (Moss et al. 2005). This is because the context changes and adjustments are necessary. For example, new participants are required and new problems have occurred. In this way, AR can be thought of as continuous process to solve environmental problems at hand.

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Appendix A: Glossary

A list of key terms used in this thesis is provided in alphabetical order in table A-1.

Table A 1: List of key terms

Key terms	**Meaning**
Black box	Knowledge constrains about an actual phenomenon, e.g. social decisions, are replaced with black boxes, which consist of assumptions about the phenomenon (Moss et al., 2005)
Co-evolutionary	In transition to sustainable socio-technical systems, multiple processes of institutional, technological, behavioural, ecological, economic and other processes intertwine and reinforce each other (Kemp et al., 2007)
Competing environmental discourses	Contested knowledge about environmental problems and solutions (Farmer and Guy, 2001; Hajer, 1995)
Constructivist	A perspective in social sciences. Reality cannot be captured in a single frame, a theory that describes how social process works. Reality is made by those who do and unfolds through time and space (Law, 2004)
Discrete environmental technologies and innovation	Environmental innovation understood as change in technologies in which the development and uptake of specific technologies are analysed (Berkhout, 2002)
Environmental discourses	Discourses consist of claims to knowledge that manifest in social practices as story lines or images of performances required with reference to environmental problems and solutions (Hajer, 1995).
Environmental innovation	The development of novelty to achieve superior environmental performance
Environmental innovation	The development of novelty to achieve superior environmental performances unfolds through time and space (Van de Ven et

journey	al., 1999; Rip and Schot, 2002)
Essentialism	Reality consist of essential properties that can be captured in a single frame to explain how reality works (Law, 2004)
Ethnography	The study of social processes (Law, 2004)
Fluidity	The environmental innovation journey refers to the idea that the development of novelties are ongoing and shaped by multiple and competing imaginings. The Researcher suggests that, rather than static snap shots, environmental innovation is fluid.
Images of performances	Participants in social practices has views about present and desired performances
Interpretive Framework	A framework that consists of analytical categories identified in literature to aid sense making
Legitimacy	Elements of social practices that are produced and reproduced are legitimate. Legitimacy is reinforced by discourses.
Non-linear process	A dynamic process that does not proceed progressively from start to finish
Path dependency	Technical regimes are 'locked' in a pattern that consist of prevailing knowledge and problem-solving heuristics that restrict transition to new technical regimes (Nelson and Winter, 1982)
Pervasive stories	Story lines found in social practices that affect the development of these
Persuasive stories	Story lines found in social practices that are socially accepted and make sense to participants involved
Power of discourses	The idea of power follows Machiavelli and consist of persuasive and pervasive story lines, which are linked to broader discourses in society, that shape social practices
Rational Choice	Individual decision making involves a choice between various options and individuals selects those options that optimises a

	particular performance
Realism	Reality exist 'out there' independent of the observer (Law, 2004)
Researcher-as-insider	A researcher positioned within the phenomenon studied, e.g. participant observation, and interact with the actual social process (Herr and Anderson, 2005)
Researcher-as-outsider	A researcher positioned outside the phenomenon studied with limited interaction with actual social process (Herr and Anderson, 2005)
Resource productivity in food and farming sectors	Refers to the challenge of reducing the use of natural resources needed in food production, e.g. water, energy and land use, while maintaining or increasing the level of product outputs (Imeche, 2013)
Situated	Social processes are situated and unfold through time and space. Context matters and shape social processes.
Situated practices	Refers to the idea that practices are contingent upon particular time and space contexts. A practice only exists through recurrent moment of performances in terms of what people do. A practice can therefore not be separated from its context.
Social practice	People do things in conjunction with technologies
Social practices in a firm	A firm is site in which many social practices are interlinked. People produce performances in conjunction with technologies in relation to images of performances required. Social practices in a firm go beyond firms traditional boundaries.
Social process	A process that consist of people as participants and unfolds through interactions and negotiations between participants in specific time and space contexts
Socio-technical system	Configurations of social as well as technical entities that work as to fulfil functions in society such as energy, food and mobility.

Space	Geographical space
Structuration	The concept of structuration builds on the work of Giddens (1984) and emphasises that actors are embedded in structures. These structures exist as rules, e.g. way of understanding the world around us, and resources, e.g. people, things and their use. These structures are constructed by people. Hence, while people are embedded in structures, they also reproduce these structures. This means that people draw upon structures so as to perform actions. Seen this way, structures are something that is constraining as well as enabling human action.
Stylist accounts	Theory about reality presented in a single frame that have enough detail to capture the essential properties of social process, while simple enough to be applicable to understand social process in different contexts
Unilinear process	A process that proceeds progressively from start to finish

Appendix B: Data collection via semi-structured interviews

Information about data collection via semi-structured interviews includes:

- Development of research topics that informed data collection via interviews
- List of interviews conducted in this study

How research topics were developed to inform data collection in this study

Information about research topics developed in the beginning of this study is provided in table B2. This table reflect the research perspective developed in section 2.3.5 and 5.1. Two 'big' questions were identified: how are (1) environmental problems, and (2) solutions constructed? These 'big' questions stimulated development of 'mini' questions such as what are the environmental problems and solutions, who articulate these, what are they doing about it and why? In this way, a number of research topics was identified and informed data collection using ethnographic methods (i.e. participant observation and semi-structured interviews.

Table B 1: Research topics that informed data collection

Big questions	**Mini Questions**	**Research Topics**
How are environmental problems constructed?	What are the environmental problems? Who identifies and articulate environmental problems? Why are environmental problems articulated?	Environmental problems Motivations Participants
How are environmental Solutions	What changes are made in the Firm to resolve environmental	Solutions to environmental problems

Constructed?	problems? Who identify solutions to environmental problems? What motivates these changes?	Motivations Participants

Semi-structured interviews were undertaken with participants in the Firm. A list of interviews conducted in this study is provided in table B2. Questions asked in interviews were specific to each respondent and reflected research perspective developed in this study. All interviews were transcribed and analysed. An extract from one interview is provided subsequently.

Table B 2: List of interviews conducted in this research

Respondents	**Date**
Sales Director	September 2009
Sales Manager	July 2009
Procurement Director	January 2010
Procurement senior manager	March 2010
Water Engineer/ Environment Officer	March 2010
Procurement Manager and Environmental Officer	June 2010
Planning Manager	June 2010
Production manager (PM) ; Shift manager (SM) Shift leader (SL); Environmental officer (EO)	June 2010
Accounts Manager	June 2010
Raw Material Manager	June 2010
Sustainability Champion	July 2011
Factory Manager 1	August 2011

Appendix C: Data collected via participant observation

Information about data collection via participant observation includes:

- List of participants accounted for in this study
- List of organisations accounted for in this study
- List of technologies accounted for in this study
- Extract from the reflective diary
- Details from the environmental management workshop

List of Participants, organizations and technologies accounted for in the study

Data from participant observation were collected using a reflective diary. Observations recorded using the diary accounted for many participants, organisations and technologies that are specific to the Firm. Details about these specifics are provided in tables A-4, A-5 and A-6.

Table C1 provides a list of participants accounted for in this study.

Table C 1: List of participants accounted for in this study

Participants	Acronym	Description
Environmental Officer	EO	An engineer with particular responsibility for the environmental management in the Firm. This role established in March 2010. The Environment Officer was enrolled as Water Engineer before this appointment
Engineers		Members of the engineering function in the Firm
Engineering Manager		Person responsible for the management of the engineering department in the Firm.
Factory Manager 1	FM1	Factory Manager with particular responsibility for production in particular and Firms operations in general. This role established in March 2009 and replaced by

		Factory Manager 2 in February 2010
Factory Manager 2	FM2	Factory Manager with particular responsibility for production in particular and Firms operations in general. FM2 was enrolled in February 2010
Group Advisor		Person enrolled by Parent Group. Worked with the Firm in strategic projects
Group Sustainability Champion	GSC	Enrolled by Group with responsibility for the development and implementation of the Group Sustainability Strategy. GSC was former Sales Director in the Firm
Health, Safety and Environment Manager	HS&E	Person with responsibility for health, safety and environmental matter in the Firm. He left the firm in June 2009.
Hygiene Manager		Person with responsibility for the cleaning of the Factory and food processing equipment
Managing Director 1	MD1	Firm's MD during project start until January 2010. Industrial supervisor of this project during this time
Managing Director 2	MD2	MD appointed as interim in January 2010 until September 2010
Managing Director 3	MD3	Firm's MD from September 2010
Marketing Consultant		Consultant enrolled by MD1. Provided marketing advice to the Firm
Operational Director		Operational director enrolled to develop and implement a 'lean manufacturing' framework in production
Production Manager		Person in the Firm with particular responsibility to manage production.
Production Staff		People working in production

Project Engineer Manager		Person enrolled to manage distinct projects in the Firm
Raw Material Manager		Person working in the technical department responsible for the quality of vegetables supplied to the factory
Researcher		The student undertaking this PhD project
Sales Director		Person enrolled as director of sales in the Firm. Became Group Sustainability Champion in subsequent events
Supervisor 1		Academic Supervisor of this PhD
Supervisor 2		Academic Supervisor of this PhD from October 2010
Technical Director		Technical Director is head of the technical department in the Firm. He worked at Parent Group and engaged with Firm at certain times.
Water Engineer		An engineer in the Firm with particular responsibility for water use and treatment. This role was extended as Environmental Officer in March 2010
Water Treatment Consultant		Consultant enrolled by Group Advisor with a particular focus to identify solutions at the Water Treatment Plant in January 2009

Table C2 provides a list of organisations accounted for in this study.

Table C 2: List of organisations accounted for in this study

Organizations	**Acronym**	**Description**
Environment Agency	EA	An organization that regulates environmental protection in the UK
Firm		The UK food processing firm in which this study was undertaken. And project sponsor
Food and Drink Federation	FDF	UK food industry organisation responsible for a voluntary agreement to improve

		environmental impacts in the UK food industry sector. The Firm was committed to this voluntary agreement
Group Divisions		Other companies owned by the Parent Group
Marks and Spencer	M&S	UK Food retailer
Parent Group	PG	The Parent Group is the Firm's owner

Table C3 provides a list of technologies accounted for in this study.

Table C 3: List of technologies accounted for in this study

Technologies	**Acronym**	**Description**
Artefacts: Management Frameworks found in the Firm		
Environmental Reporting Framework		A framework developed in a workshop in the Firm identifies environmental themes, cleaner production measures and environmental performance indicators. This framework was developed and abandoned in July 2010
Factory Management Framework: Daily Reviews		A framework developed to organise activities in production. Involved a particular focus on production performances (e.g. customer service and production yields). Developed in March 2009 and used as template for a new framework developed in February 2010)
Firm's Environmental Strategy		Firm's strategy identified to pursue cleaner production initiatives
Lean Manufacturing Framework		A particular framework developed in production to measure and monitor production throughput. This framework was abandoned in March 2009
Sustainability		A strategy developed at Parent Group by GSC to

Strategy		identify and pursue cleaner production measures, including social responsibilities
Devices: Distinct technical devices found in the Firm		
Membrane-Bio-Reactor	MBR	Water treatment technology
NOBO board		A white board introduced to production meetings by FM2 to organise production performances. Established in March 2010
Water Balance Framework		A framework which identifies a firms' or other activity's water input, water use, and water output at a particular time
Water Meters		Technical device to quantify water running through a water pipe
Water Treatment Plant	WTP	The Firm owns and runs a water treatment plant to sanitise water used in production
Infrastructure: Technical systems found in the Firm		
Factory		The site were the Firm's production takes place
Water system		The system of borehole, water pipes and water pumps developed in the Firm to supply production in the factory with water

Details from the work shop undertaken in the Firm

A work shop was carried out with participants in the Firm. The purpose of this workshop was to integrate environmental management with the overall operational framework in the Firm. This workshop was recorded and transcribed for data analysis purposes. A summary of workshop details are provided:

Introduction and Overview of the Process

The environmental management workshop was carried out with participant from the Firm to specify the Firm's environmental challenges and develop strategic objecives and success indicators.

Date & Venue:	June 29th 2010 at the Firm
Purpose:	To specify The Firm's environmental challenges and response
Facilitators:	The Researcher, the Environment Officer, Supervisor 1 & 2, Factory Manager 2
Participants:	MD2, Engineer Manager, Warehouse Manager, Finance Manager, Technical Assistant Manager, Transport Manager, Production Shift Manager, Raw Material Manager
Outcome:	An environmental management framework which includes key environmental challenges, strategic objectives and key performance indicator.

The action research process

Action research (AR) is the method adopted to improve aspects of the Firm's environmental performance. AR can be described as a cyclic learning process which includes the following stages: (1) idenitfying the issues at hand; (2) developing the objectives and success indicators; (3) develop action plans to meet the objectives; (4) implament the action plan; and (5) review the change and decide what to do next. This initial workshop has addressed stage 1 and 2. An overview of the AR process is detailed in figure 1 below.

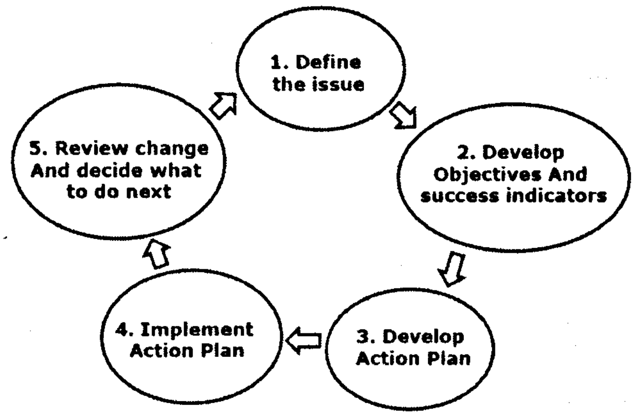

Figure A- 1: Action Research Process

The workshop process

The workshop process was carried out in two phases:

Phase 1: Specify The Firm's environmental challenges (1 hour)

- Introduction by the Environment Officer about the Firm and the environment
- Group session 1 was carried out in two groups to specify the Firm's environmental challenges
- Feed back from the groups

Phase 2: Develop strategic objectives and key success indicators (1 hour)

- Introduction by the Researcher about environmental strategy, management & environmental innovation
- Group session 2 was carried out in one large group to specify the Firm's response to the environemtnal challenges
- The Workshop outcomes

Workshop outcomes from phase 1

The Firm's Environmental challenges was disscussed in two separate groups for 20 minutes and feed back for 15 minutes. The following environmental themes and specific challenges were articulated:

- **Solid Waste Streams**: Landfill, by-products, packaging waste (e.g. wood, cardboard, plastics), waste segregation

- **Water use**: Water treatment capacity – limit to growth, the infrastructure (e.g. water pipes and water pumps), specific water use (e.g. hygiene, peelers, temperature control)

- **Energy consumption**: Specific activities that use electricity (e.g. storage, effluent plant, vacuum system, compressors) and specific routines (e.g. temperature control, hours running, office computers, lights)

- **Transport**: The Fleet (e.g. Food miles, Planning, tracking, vehicle fill, fuel type); Other transport (e.g. waste disposal, forklift trucks, commuting)

Workshop outcomes from phase 2

The purpose of phase 2 was to develop a response to the environmental challenges specified in phase 1. The response to the environmental challenges specified in phase 1 were discussed in one large group for 25 minutes. The following response, shown in table C4 was developed by the participants:

Table C 4: Development of strategic objectives and key performance indicators

Themes	**Strategic Objectives**	**Key Performance Indicators**
Waste	Prevent – Reuse - Recycle	
	Reduce waste sent to landfill -	KG/Month
	Reduce by-products – Improve Yields	Yields KG/KG
	Reduce packaging waste	KG/Month
Water	Improve water efficiency	m^3/tonnes of finish product
	Improve control over water use	
Energy	Improve energy efficiency	kWh/tonne of finish product
Tranpsort	Improve transport fleet efficiency	CO_2

The following objectives was identified to facilitate a behaviolural change in the Firm:

- Raise Awareness about the Firm's environmental performance and educate people
- Identify and communicate Flagship Initiatives
- Improve Management routines around environmental performance (e.g. measuring and monitoring)
- Integrate environmental management - Develop satellite teams around environmental themes (e.g. waste, water and energy)

Concluding remarks

The outcome of the environmental management workshop can be summarised in a framework which includes the critical environmental themes specified by the participants and the developed responses in terms of stratetgic objectives and success indicators. Additionally it was recognised that improvement of the Firm's environmental performance required behavioral change in terms of awarenss and education about the environmental challenges, and management routines in terms of measuring and monitoring of environmental performance. The environmental management framework developed in the workshop is detailed in Chapter 5.2.15.

Moving forward

The environmental management workshop specified the Firm's environmental challenges and the strategic responses. To move forward require a development of action plans for each environmental theme. It was suggested that the environmental steering group (the Factory Manager 2, the Environment Officer and the Researcher) will identify participants for the "satellite-teams" who will then develop the action plans and implement change (in waste, water and energy). The satellite teams need a champion to co-ordinate each action plan and report back on progress in selected areas. Actions identified to proceed are:

- Steering group will identify key participants for satellite teams
- Developing a time plan
- Engage Satellite teams with the AR-process and develop action plans (what, when & who) and management routines (e.g. measuring, monitoring and targets) for implementing action and to review progress

Appendix D: Research ethics

Research considerations are provided in tables D1.

Table D 1: Research considerations

Department and Faculty	Department of Design, Environment and Materials
Location of Activity	The Firm and the University

PhD title	Exploring Environmental Innovation Journeys: An Ethnographic Study in a Firm from the UK Food and Farming Sector
Supervisors	Dr. Matthew Cook and Professor Stephen Potter
Name of the Researcher	Per-Anders Langendahl
Brief Summary of project aim and method	Data will be collected through interviews and participant observation. Data that has been collected is codified to ensure anonymity and analysed through appropriate frameworks.
Location of activities	The Firm and the University
Time Scale	October 2008 June 2012

How will consent be obtained:	Verbal consent and contract agreement was established with the Firm and participants to collect data
Does the procedure involve any possible distress or harm to participants:	Data collection using ethnographic methods was undertaken in the Firm. Distress or harm to participants was avoided though the following measures: (1) the role of the researcher was made clear to participants, (2) participants were anonymized, and (3) participants could withdraw from interview or interaction with the researcher at any point in time.

How can participants withdraw from the study	The participants can withdraw from interview or avoid interaction with the Researcher at any point in time. Any publication involving data collected in this study is shown to representative from the Firm to review prior to publication
How are confidentiality and/or anonymity to be maintained	Key participants are coded by the researcher, and reflect their role or relationship with the Firm e.g. production manager is coded PM, while participants from outside the firm are coded, e.g. consultant or the University A participant can withdraw from a workshop or interview at anytime, if he or she wish to do so Data that has been provided to the researcher can be destroyed, if key participant so wish Findings from data collection will be agreed with key participants before publishing in *inter alia* academic journals or conference papers Statements from interviews will not lead to any professional disadvantage
What information will you give participants in debriefing	Participants was informed about the role of the researcher and details about the research project
Any other ethical issues	
Hazards/Risks	Introduction to health and safety at the Firm on arrival.
Data protection	Data collected in the Firm is kept in files in office that is looked. Data is storied in files on computer protected with password only known to the researcher

Contact details	

Name	Per-Anders Langendahl
Unit	DDEM
Address	80 A The Green, TW2 5AG, Twickenham
Telephone	07517877998
Email	p.langendahl@open.ac.uk
Signature	
Date	2012-06-29

Appendix E: Research outputs

This appendix provides a summary of research outputs.

Conference papers

Title	**Exploring the eco-innovation journey in a firm from the UK food processing context**
Authors	Per-Anders Langendahl, Stephen Potter and Matthew Cook
Conference	EASST Conference: Practicing Science and Technology, Performing the Social September 2nd-4th 2010 Trento – Faculty of Sociology
Track 37	System Innovations and Transitions to Sustainability

ABSTRACT

Food and sustainability is an emerging field of research that seeks to analyse environmental (and socio-economic) impacts arising from patterns of food production and consumption. Many authors suggest that technological changes provide opportunities to move society away from unsustainable food systems and improve among other things resource productivity. Stimulus for environmental innovations is in general thought in terms of economic and regulatory factors. In contrast, systemic views of food systems and innovation that might lead to a sustainability transition address impetus factors of trends in market conditions and power relationships between supply chain actors such as retailers, food manufacturers and farmers. However, little is known about the micro-level dynamics of environmental innovation process within food sectors. This paper draws on results of a research project situated within a UK food processing firm. The theoretical background draws on innovation and organization literatures to frame a concept of 'eco-innovation journey' as a socio-technical, messy and non-linear process. The method identified to explore the construction of eco-innovation process within this firm was a longitudinal case study undertaken through action research. An ethnographic approach was adopted, involving participant observation and data were collected via reflective diary and semi-

structured interviews. Findings were analysed using coding and clustering methods to make sense of data sets. Provisional results suggest that learning around eco-innovation is an iterative process of information, knowledge and measures, which is shaped by enacting environmental factors. More specifically, it was found that the cost of factor inputs and environmental regulation provide a rationale for eco-innovation activities, which often encompassed techno-centric and ad hoc solutions to identified issues. Moreover, the politics of enrolment, power relationships and fluid participation of actors have great influence over the nature and direction of the eco-innovation journey in the firm.

Title	**Analyzing the Eco-Innovation Process in a UK Food Processing Firm**
Authors	Per-Anders Langendahl, Matthew Cook and Stephen Potter
Conference	Sustainable Innovation 2010, RDM Campus Rotterdam The Netherlands 8th-9th November 2010, www.cfsd.org.uk

ABSTRACT

The eco-innovation process can be defined as deliberate shifts undertaken by firms to move away from unsustainable practice (Ehrenfeld, 2008). Such shifts might include changes in technologies, and ways of thinking about these to improve ecological performance e.g. resource productivity. The literature on innovation provides rich accounts of the factors which might stimulate the development of eco-innovations e.g. environmental regulation or competitiveness, and the consequences of implementing new technologies. However, there is relatively little literature which considers the eco-innovation process.

This paper reports results from a study on eco-innovation in the context of food and sustainability. Although much of the research on this particular topic has concentrated on farming and the behaviour of consumers, little is known about the intermediate actors e.g. food processors and manufacturers who provide a critical link in the food

supply chain. This paper presents research from a firm in the UK food processing sector to help address these two gaps in knowledge. The paper draws on innovation and organization literatures to frame a concept of 'eco-innovation journey' as a socio-technical, messy and non-linear learning process. The framework developed in the research describes eco-innovations as a process of temporal sequence of events that might explain how practice changes in a firm over time. These events include, among other things, changes in ideas, people interactions and selective attention of participants. Hence, eco-innovations encompass a messy process in terms of twists and turns, leaps and dead-ends that are inherent with the eco-innovation journey.

The method identified to explore the construction of eco-innovation process within a UK food processing firm was a longitudinal case study undertaken through action research (AR). The relationship with the firm made AR possible for the researcher to participate in the learning of, and action around eco-innovations. Moreover, an ethnographic approach was adopted to explicate events of eco-innovation activities over time, involving participant observation. Qualitative data were collected via reflective diary and semi-structured interviews. Findings were analysed using coding and clustering methods.

Results from this longitudinal case study suggest that learning of, and actions around eco-innovations can be described as an iterative process, which includes three critical elements: information, knowledge and measures. Information includes motivating factors, internal and external to the firm, articulated by participants, e.g. cost of factor input and environmental regulation. Knowledge resulting from the learning processes in the firm can be described as cyclic, and involves experimentation and success indicators e.g. ecological performance. Finally, measures developing as results of learning processes describe eco-innovations in terms of management, technical or marketing solutions. Moreover, the interplay of many actors that engage and disengage in the eco-innovation journey over time makes it a messy and dynamic process in terms of power struggles and negotiations. Overall, this study identifies that the dynamics of many variables and fluid participation of actors that forms the conditions determining the nature and direction of eco-innovations in the firm.

Title **Towards a New Understanding of Environmental Innovation**

Authors Per-Anders Langendahl, Matthew Cook and Stephen Potter

Conference Sustainable Innovation 2011, Farnham Castle, Farnham, UK, 24th-25th October 2011

ABSTRACT

Transitions to sustainable socio-technical systems which satisfy societies need for functionalities (e.g. shelter, transport) are the focus of a growing literature. One key development has been the multi level perspective (MLP), which is intended to assist in this matter. The MLP conceptualizes socio-technical systems as a three level nested hierarchy. Slow moving variables are accounted for at the macro level, in a highly structured landscape. Configurations of heterogeneous elements that work to achieve society's functionalities comprise a messo level socio-technical regime. New configurations which may eventually be taken up at the messo level as part of transition processes are developed at the micro level, in niche environments.

Strategic Niche Management (SNM) is a transition framework that involves building on socio-technical system dynamics to purposively create niche environments in which new configurations may be developed to achieve transition to alternate socio-technical regimes. SNM is thought to offer those interested in transition to sustainable socio-technical systems an opportunity to develop new configurations which may help attain this goal. However, a number of limitations to the MLP and SNM have been identified and their utility questioned. Limitations of concern include, an over emphasis on pre-given functionalities, the instrumental value of socio-technical configurations and supply side agency. Thus as in many instances, research in this field may be useful and valid but provides partial accounts which may be usefully added to.

To address this gap in knowledge, the findings of ethnographic research which focused on how environmental innovation unfolds in niche environments are reported

in this paper. These indicate that activity at the niche level is in a constant state of flux, with entities (people and things) and relationships between them constantly changing, being made and remade. From such processes environmental innovations emerge. These cannot be usefully thought of as technologies but as practices which are constituted and reproduced to address environmental problems, identified by actor coalitions as useful to resolve. Just as firms have been shown not to be driven by the singular goal of profit maximisation, there are many logics which compete via actor coalitions in the constitution and reproduction of practices. These were found to include Eco-prenural, long term survival, techno-centric and form the focus of this paper.

Overall the research argues that similar to the work undertaken by Shove and others on innovation in user practices, innovation undertaken within a firm, within a niche environment, is complex, uncertain and contingent. This suggests that environmental innovation is guided by competing logics but is very difficult to control. This is not to deny that there is a capacity for action. Rather, that environmental innovation is uncontrollable in a modernist management sense. Indeed, there is a capacity for action and the pursuit of sustainability is an important if not always prominent, motivator.

Presentations of research findings

A list of presentations by the Researcher are provided subsequently

Title	An Ethnographic Study of the Eco-Innovation Journey in a Firm from the UK food and Farming Sector
Venue & Date	The Open University Design Group Seminar, April 28th, 2010

Title	An Ethnographic Study of the Eco-Innovation Journey in a Firm from the UK food and Farming Sector
Venue & Date	The Open University Student Conference, May 18th, 2010,

Title	Environmental Management Workshop
Venue & Date	The Firm, June 29th, 2010

Title	Exploring the eco-innovation journey in a firm from the UK food

	processing context
Venue & Date	EASST Conference: Practicing Science and Technology, Performing the Social September 2nd-4th Trento – Faculty of Sociology

Title	Analyzing the Eco-Innovation Process in a UK Food Processing Firm
Venue & Date	Sustainable Innovation 2010, RDM Campus Rotterdam The Netherlands 8th-9th November 2010

Title	Practice View of Environmental Innovation: A Case Study of a UK Food Processing Firm
Venue & Date	SLU: the Swedish University of Agricultural Sciences, October 17th, 2011

Title	Towards a New Understanding of Environmental Innovation
Venue & Date	Sustainable Innovation 2011, Farnham Castle, Farnham, UK, 24th-25th October 2011